Learning Outcomes Data

for the

Senate Committee on

Instructional Program Priorities

Program: Graduate Program (M.S. in EEE)

Department: Electrical & Electronic Engineering (EE)

Number of students enrolled in the program in Fall 2011: 139

Faculty member completing template: Preetham B. Kumar

Date: 02/01/2012
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 first assessment cycle was completed in January 2011, and the EEE graduate program was fully approved until the next review cycle. We are working on the suggestions of the reviewer, in an effort to improve the assessment and review process.

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.

   **Desired Learning Outcomes**

   The following four learning outcomes have been prioritized from our original ten outcomes:

   a) A knowledge of core and advanced EEE topics
   b) Depth in at least one area of EEE out of Analog/Digital Electronics, Control Systems, Communications and Power.
   c) The ability to use contemporary engineering techniques and tools for analysis and design
   d) The ability to communicate effectively

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.

   This is not applicable for the EEE graduate program.

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.

   **Course based assessment**

   Outcomes (a), (b) (c) and (d) were monitored and measured through assessment of some key core courses in the EEE curriculum. The following courses and course outcomes were monitored:

   EEE 201 – Research Methodology (Required core class for all graduate students)

   **Course outcomes**
• CO-1: Able to select a contemporary project topic in Electrical/Computer Engineering, and complete a clearly written Topic Form
• CO-2: Able to write a concise introduction and related bibliography for the selected project topic

EEE 244 – Electrical Engineering Computational Methods and Applications (Required class for all graduate students)

Course Outcomes

• CO-1: Use Matlab as a tool in engineering analysis and design in future courses, design projects and professional work assignments.
• CO-2: Use and apply numerical analysis techniques to electrical engineering problems.

EEE 285 Micro-Computer System Design I. (Required core class for Digital area)

Course outcomes

• CO-1: Students will design systems based on logic that includes PC system bus, architecture components.
• CO-2: Students will understand PC architecture/components technologies when using schematic design tools.
• CO-3: Students will acquire extensive hands-on laboratory skills (understanding technical specifications, designing to industry specifications/protocols, generating schematic diagrams).
• CO-4: Students will design implementations of PCI based bus protocols, arbitration policies, CPU out of order execution contemporary cache and virtual memory architectures. Students will practice writing a technical, grammatically correct report and technical papers. Students will also learn professional presentation skills.
• CO-5:

EEE 211 – Microwave Engineering (Required core class for Communications area)

Course outcomes

• CO-1: Use scattering parameters for microwave measurement (Midterm-I)
• CO-2: Design practical transmission lines such as waveguides, microstrip and stripline. (Midterm 2)
• CO-3: Design, simulate fabricate and test passive microwave devices including filters, couplers, power dividers and antennas in the frequency range of 1-20 GHz. (Project)

Assessment of culminating experience (Thesis/project/comprehensive exam)

We assessed the course level assessment through the Culminating experience for graduating M.S. students. Students have the following options for their culminating experience:

Plan A : Thesis ( 5 units)
Plan B : Project ( 2 units)
Plan C : Comprehensive exam
The following Table 1 lists the statistics of the projects/thesis completed by M.S. students in the last 6 years, giving the total number of reports. Figure 2 illustrates the breakup of reports according to the five core areas in the EEE.

Table 1. EEE M.S. Project/Thesis Statistics

<table>
<thead>
<tr>
<th>Year</th>
<th>Total reports(EEE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>53</td>
</tr>
<tr>
<td>2005</td>
<td>62</td>
</tr>
<tr>
<td>2006</td>
<td>47</td>
</tr>
<tr>
<td>2007</td>
<td>30</td>
</tr>
<tr>
<td>2008</td>
<td>47</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
</tr>
<tr>
<td>2010</td>
<td>58</td>
</tr>
</tbody>
</table>

Figure 2. Number of projects/thesis completed in EEE graduate core areas

Assessment from Comprehensive exam data

The following Table 2 lists the number of students who took the Comprehensive exam option in the past 3 years (since it was offered), giving the total number of students by semester, and also the breakup of students according to the 5 core areas in the EEE graduate program. The exam is offered once every semester, and students are given 2 attempts to pass the exam. Table 2 below shows the number of students who took the exam, and passing number, from the last 7 semesters. The exam was initiated in Fall 2007.
Table 2. EEE Comprehensive Exam Statistics

<table>
<thead>
<tr>
<th></th>
<th>Total students</th>
<th>Students passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2007</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Spring 2008</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Fall 2008</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Spring 2009</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Fall 2009</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Spring 2010</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>Fall 2010</td>
<td>31</td>
<td>16</td>
</tr>
</tbody>
</table>

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.

**Student sample**

The data was collected from EEE graduate students, with equal distribution over the five areas of specialization: Power Systems, Communication systems, Control Systems, Microelectronic Design, and Computer Architecture & Digital Design.

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.

**Course based assessment**

The course outcomes for the four key courses, EEE 201, EEE 244, EEE 285, EEE 230 and EEE 211 have been described in the previous section. These course outcomes are directly related to the SLOs, and are tested in proposed assessment tests in each of these courses.

**Assessment of culminating experience (Thesis/project/comprehensive exam)**

The assessment committee met in December 2010 and reviewed 15 EEE project reports that were completed in the years 2008-2009, 3 each from the five different areas of specialization. Reports were classified into 3 categories: Excellent, Good and Fair, based on extent of work done by the student, and also presentation of the report. The 15 reports, after review by the assessment committee were listed as follows:

*Excellent:* 3
*Good:* 10
Fair: 2

Review

The Assessment Committee reviewed the Plan C results in Fall 2008, when there were sufficient numbers to evaluate, and determined that passing rate was in the 70% range.

d) Explain how the program faculty analyzed and evaluated (will analyze and evaluate) the data to reach conclusions about each desired student learning outcome.

Course based assessment

The following reviews were obtained from the course based assessment:

**EEE 201 Review:** The assessment committee met in December 2010 and reviewed the effects of recommendations made in the earlier assessment. It was noticed that writing skills, as evinced from the projects, show improvement in quality, in both outcomes CO_1 and CO_2. Student awareness to proper acknowledgement of references and citations has also improved; however, this is one area, where we need to keep working on. Newer approaches planned include inviting speakers from industry and other departments, like the English department, to give students a more detailed view of plagiarism and work ethics.

**EEE 244 Review:** The assessment committee met in December 2010, and reviewed feedback from student performance in the Spring 2010, and also views of the instructor. The earlier course grading was based on in-class labs and take-home project, however, the instructor felt that students do not apply themselves that well to the take-home project, hence the committee recommends that the instructor use only in-class labs, to better judge student performance.

**EEE 285 Review:** The assessment committee met to discuss the course in December 2010 and determined that the addition of new projects did improve student expertise in the area. Future steps are to increase student performance in projects through some additional in-class project reviews.

**EEE 211 Review:** Generally, it is found that students perform well in the theory, though certain complex concepts like scattering parameters (CO_1) do offer challenges to students. Additionally, some students also faced certain challenges in CO_3, which corresponds to the design, fabrication and testing of one microwave circuit. In order to improve this practical aspect, more lab sessions were recommended.

**Thesis/project reports**

Based on this review, it was observed that a number of reports, supervised by one faculty member, were in the **Fair** category. It was also observed that the single faculty member had signed up as advisor for more than 25 graduate students. This faculty member was not
permitted to advise additional students on their projects for one year, until all the existing students were cleared.

**Comprehensive exam**

The committee also discussed ways to improve the passing rate in the comprehensive exam, including giving more time for students to prepare for the exam, and sending e-mail reminders to students on the exam guidelines and passing grade.

**Overall Review for projects/thesis and comprehensive exam**

Some significant trends are seen in the data presented above: while the number of projects/thesis has steadily decreased over the past 5 years, the number of students choosing the comprehensive exam option has increased. This trend can be partially attributed to the fact that the number of students in the EEE M.S program has steadily increased over the years, and it is not possible for a limited number of faculty to provide M.S. project/thesis topics to more than a limited number of students. This results in students increasingly opting for the comprehensive exam option for their culminating experience.

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.

**Examples of faculty actions to address assessment findings- core course action**

One such action was for the core class EEE 230, which is the Microelectronic Design core:

Between the Spring 2010 semester and the Fall 2010 semester online quizzes and exams were implemented for EEE 230. This provides students the ability to practice solving problems in these classes far more than conventional homework, as each student can try each quiz as many times as they need until they understand the material covered on that quiz. The quiz questions are taken from large question banks and both the problems selected for each quiz and the numbers in each problem change each time the quiz is attempted. Students are provided with immediate feedback regarding whether or not they got the right answer to each question, and are given the correct answer if they miss the question so that they can check their work and make needed corrections before the next attempt. The improvement in student grades is seen below from Spring 2010 to Fall 2010.

<table>
<thead>
<tr>
<th></th>
<th>Spring 2010</th>
<th>Fall 2010</th>
<th>Change (points)</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes</td>
<td>85.63</td>
<td>92.86</td>
<td>7.23</td>
<td>8.45</td>
</tr>
<tr>
<td>Midterm exam</td>
<td>60.15</td>
<td>82.00</td>
<td>21.85</td>
<td>36.33</td>
</tr>
<tr>
<td>-------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Final exam</td>
<td>53.20</td>
<td>75.56</td>
<td>22.36</td>
<td>42.02</td>
</tr>
<tr>
<td>Overall Average</td>
<td>69.55</td>
<td>88.01</td>
<td>18.46</td>
<td>26.55</td>
</tr>
</tbody>
</table>

**Examples of faculty actions to address assessment findings- from Culminating experience (Thesis, project and comprehensive exam)**

In regards to the number of students taking the Plan C exam has considerably increased from 11 students in Fall 2008 to 25 students in Spring 2010. The Assessment committee again reviewed the Plan C exam results in December 2010, and reviewed the results from the earlier semesters. It was observed that the predominant number of EEE students taking the Plan C exam is in the Digital and Microelectronic areas. However, within these two areas, the passing rate has been quite low between 40 – 50 %. On analyzing this trend, and the reasons for this lower passing rate, one important finding was made: Students sometimes take the exam for the first time on a trial basis, or in the case of international students, just to extend their student status.

Additionally, we have advised the instructors to stress on the fundamentals in these core courses, so as to allow students to retain these concepts through the end of their graduate program and beyond.

**Examples of faculty action to address findings in both course work and culminating experience**

Since the Digital and Microelectronic areas are two of the heavily populated areas of the graduate program, as evinced from the comprehensive exam profile (given in the previous section), it was suggested to introduce a Certificate in Mixed-Signal Integrated Circuit Design. Here is a brief list of the certificate goals and requirements:

- This requires studying multiple subjects such as amplifier design, device physics and matching, analog layout techniques, and key mixed-signal circuit blocks. In addition, students learn the methods and tools used to design and layout ICs.
- Fully embedded within the Master's Degree program offered by the Department of Electrical & Electronic Engineering
- Offered to students for no cost.
- Provides potential employers with evidence of the skills students have developed

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.

**Surveys from industry**

An EEE/CpE faculty team visited Intel Corporation, Folsom in May 2007, and talked informally with 7 former graduate students, who were also informed of the meeting earlier through e-mail.
Topics discussed were based around the following questionnaire:

1) What CSUS learning experiences were most valuable to you in your career?
2) What knowledge and skills that you acquired during your education have you used most?
3) What knowledge do you use the least?
4) What do you wish you had learned in school but did not?
5) What are the emerging and expanding fields in computer engineering?
6) What critical skills and knowledge will computer engineers need for the future?
7) For managers: What are the strengths and what are the weaknesses of our graduates of the CpE program?

**Review**

The feedback we obtained from Intel engineers included suggestions for the following topics to be covered in our courses: Object oriented programming, databases, C, Perl, multiprocessor programming, GUI, WiMax, technology for mistake prevention, data management, communication skills, and globalization. In addition, tools like the Plan C exam, and a possible combined B.S. /M.S program were also welcomed.

Our faculty reviewed all the feedback carefully, and is steadily including some suggested topics in their courses. As an example, WiMax technology and some of the suggested digital topics are now included in elective classes. The Plan C exam is now very popular among graduate students, and serves as a convenient culminating experience to graduate students, who would like to enter industry quickly after graduation. The department will continue to incorporate such kind of industry feedback into our courses.

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?

This is not applicable for the graduate program, since the professional ABET accreditation is applicable for the undergraduate program only.

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?

The first assessment cycle was completed in January 2011, and the EEE graduate program was fully approved until the next review cycle. We are working on the suggestions of the reviewer, in an effort to improve the assessment and review process.