Washington State University  
School of EECS  
Electrical Engineering Course Assessment Report

Course Number EE 416  
Course Title Electrical Engineering Design  
Semester Offered Spring 2006  
Instructor P. Pedrow  
10th Day Enrollment 24  Number Completing Successfully (C grade or better) 23

I. Assessment Outcomes from the Course Syllabus

☐ (A) Ability to apply knowledge of mathematics, science and engineering.  
☐ (B) Ability to design and conduct experiments as well as analyze and interpret data.  
☒ (C) Ability to design a system, component, or process to meet desired needs.  
☒ (D) Ability to function on multidisciplinary teams.  
☒ (E) Ability to identify, formulate, and solve engineering problems.  
☐ (F) An understanding of professional and ethical responsibility.  
☒ (G) Ability to communicate effectively in written and oral formats.  
☐ (H) A broad education necessary to understand the impact of engineering solutions in global, economic, and societal context.  
☐ (I) Recognize the need for, and have the ability to engage in lifelong learning.  
☐ (J) Have a broad education and knowledge of contemporary issues.  
☒ (K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.

II. List of Course Topics from the Course Syllabus

1. Team design project  
2. Monthly oral progress evaluation of teams by instructor  
3. Written progress report  
4. Written final report  
5. Formal midterm presentations to instructor and faculty/industry mentors  
6. Formal final presentations to instructor and faculty/industry mentors  
7. Poster presentations and equipment demonstrations judged by industry panel
### III. Course Assessment Summary Table: one row of the table should be devoted to each of the checked outcomes in part I.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Topics</th>
<th>Specific Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>1, 4, 7</td>
<td>• Fourth Quarter Poster (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fourth Quarter Written Final Report (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Peer &amp; Mentor Evaluation (Individual Score)</td>
</tr>
<tr>
<td>(D) Ability to function on multidisciplinary teams.</td>
<td>1, 2, 3, 4, 5, 6, 7</td>
<td>• First Quarter Oral Evaluation (Individual Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Second Quarter Oral Evaluation (Individual Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Second Quarter Written Progress Report (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Third Quarter Oral Evaluation (Individual Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fourth Quarter Poster (Team Score)</td>
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<tr>
<td></td>
<td></td>
<td>• Fourth Quarter Written Final Report (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Peer &amp; Mentor Evaluation (Individual Score)</td>
</tr>
<tr>
<td>(E) Ability to identify, formulate, and solve engineering problems.</td>
<td>1, 4, 7</td>
<td>• Fourth Quarter Poster (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fourth Quarter Written Final Report (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Peer &amp; Mentor Evaluation (Individual Score)</td>
</tr>
<tr>
<td>(G) Ability to communicate effectively in written and oral formats.</td>
<td>2, 3, 4, 5, 6, 7</td>
<td>• First Quarter Oral Evaluation (Individual Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Second Quarter Oral Evaluation (Individual Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Second Quarter Written Progress Report (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Third Quarter Oral Evaluation (Individual Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fourth Quarter Poster (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fourth Quarter Written Final Report (Team Score)</td>
</tr>
<tr>
<td>(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>1, 7</td>
<td>• Fourth Quarter Poster (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fourth Quarter Written Final Report (Team Score)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Peer &amp; Mentor Evaluation (Individual Score)</td>
</tr>
</tbody>
</table>
IV. Using the table as a guide, for each outcome summarize your evaluation of the students’ achievement of that outcome; cite student performance on the identified measures as evidence to support your conclusions.

(C) Ability to design a system, component, or process to meet desired needs.

For archiving and reporting purposes, each team was given an icon name from a list of “gems and minerals”. For convenience, those icon names will be used in this report. Table 1 gives a summary of team activity for Spring 2006 Semester. In EE415 each team received a sponsoring company or institution and a mentor who was a practicing engineer or scientist with the sponsor. In EE415 students had already written accepted proposals describing in vague ways the design concept to be pursued in E416. Teams were expected to iterate on modeling, simulation, and engineering analysis to reach a final design plus construct a working prototype. Students displayed their final designs and prototypes at the EECS open house poster session held on April 20, 2006. Five of the seven teams (Cobalt, Garnet, Sapphire, Topaz, and Zircon) finished the course in a very efficient manner with completed design projects. These five teams will be discussed first and then the two exceptions (Emerald and Galena) will be discussed at the bottom of this section.

Scores on the written final reports for these five teams were 100, 89, 87, 84, and 69 %. The team with the 100 % was the strongest team ever seen by this instructor. The team with the 69 % lost significant points on their technical writing skills but also because their design had problems meeting an important technical specification (still photo transmission); however it did meet several other technical specifications (transient temperature acquisition and the ability to reroute the wireless signal when a path was obstructed.) Final reports with scores in the range 80-90 % were quite good. Poster scores for these five teams were 100, 100, 100, 95, and 95 %. The posters looked very professional and the teams were very good at discussing them with the instructor, with guests, and with a panel of judges from industry. To the instructor the scores on the final written reports and the poster session show that students in these five teams showed ability to design a system, component, or process to meet desired needs.

These last two paragraphs in this section contain descriptions of outcomes for the two “abnormal” teams, Emerald and Galena. Through attrition (two students dropping the course), the Galena team of three students dwindled to a one-person “team”. This solitary student finished the design for the Galena team and passed the course with his grade on the final report being 77 % and his grade at the poster session being 95 %. Engineering results in his final report were very sound; however, without technical writing support from other team members, it was not possible for him to keep the technical writing content at the “A” level, thus his relatively low score of 77 %. His poster appeared very professional and he interacted effectively with the instructor, with guests, and with the team of judges from industry. His performance was commendable considering the fact that he could deflect none of the enquiries to teammates. These respectable scores in the face of adversity show that this student possessed an ability to design a system, component, or process to meet desired needs.
The Emerald team started as a three-person team but dwindled to a two-person team when their team leader withdrew from the course at midterm. The two-person team (Emerald) received an “incomplete” in May 2006 because their poster session was quite weak due to the absence of their former team leader (the recorded score was 50 %). The two team members were very nervous at the poster session for two reasons: 1) it was clear that they had not made sufficient technical progress (and they knew it) and 2) for both of them English is not their primary language. A redeeming part to their poster showed ASPEN simulation results and they had completed meaningful analysis on a “grounded delta” transformer bank used in a station service system at a hydroelectric dam. The team received an “Incomplete” for the course. They were given added time (summer of 2006) to finish the design and produce a strong final report. These students had invested significant time in the project and it was not reasonable to make them start fresh with a new design project just because their team leader dropped the course. By meeting twice per month with the instructor and once per month with their mentor, their oral English skills and confidence levels improved markedly. This team finished their design project throughout summer 2006 and submitted their final report August 2006. The score received on the final report was 85 %. This relatively high score combined with the important improvement in oral communication skills shows that these students also finished the course with an ability to design a system, component, or process to meet desired needs.
<table>
<thead>
<tr>
<th>Team Name</th>
<th>Number of Students on 10th Day of Class</th>
<th>Number of Student Names on the Written Final Report</th>
<th>Sponsor</th>
<th>Item Designed</th>
<th>Date Final Report Submitted</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobalt</td>
<td>4</td>
<td>4</td>
<td>InnovaTek</td>
<td>Digital Controls for Hydrogen Fuel Reformer</td>
<td>May 1, 2006</td>
<td>This team was given an extension on their final report because their team leader withdrew from the course at midterm. Initial EE416 grade was &quot;I&quot; for &quot;Incomplete&quot; but that was changed to passing grades after the final report was graded.</td>
</tr>
<tr>
<td>Emerald</td>
<td>3</td>
<td>2</td>
<td>Avista</td>
<td>Power Service to a Hydroelectric Generator Facility</td>
<td>August 17, 2006</td>
<td></td>
</tr>
<tr>
<td>Galena</td>
<td>3</td>
<td>1</td>
<td>Avista</td>
<td>Grounding System for a Generator Substation</td>
<td>May 1, 2006</td>
<td>One of these students withdrew on 02/06/2006 and the other student merely quit participating and received an F for the course. The sole remaining student passed the class. He was observed to work well with the struggling students and to work hard on the technical tasks associated with the project.</td>
</tr>
<tr>
<td>Garnet</td>
<td>3</td>
<td>3</td>
<td>ISR</td>
<td>Electro-optical Fluid Level Sensor</td>
<td>May 1, 2006</td>
<td>Awarded first place by judging panel from industry.</td>
</tr>
<tr>
<td>Sapphire</td>
<td>4</td>
<td>4</td>
<td>Boeing</td>
<td>Non-Line-of-Sight Wireless Camera and Telemetry System</td>
<td>May 1, 2006</td>
<td></td>
</tr>
<tr>
<td>Topaz</td>
<td>3</td>
<td>3</td>
<td>WSU Facilities Operations</td>
<td>Protective Relay System Replacement at WSU</td>
<td>May 1, 2006</td>
<td></td>
</tr>
<tr>
<td>Zircon</td>
<td>4</td>
<td>4</td>
<td>PNNL</td>
<td>RFID Tags</td>
<td>May 1, 2006</td>
<td></td>
</tr>
</tbody>
</table>
(D) Ability to function on multidisciplinary teams.

Each student in EE416 was assigned to a project team with typical size 3-5 students. These teams included students with diverse interests (e.g. software, hardware, electrophysics, computer engineering, analog electronics, etc.) From the standpoint of majors, the team members were a mix of electrical engineering majors and computer engineering majors. To evaluate a student's effectiveness in the team environment, at the end of the semester each student and each mentor was asked to prepare an evaluation of the student members of the team. Each evaluator (student or mentor) assigned a grade to each student on the team. Grades solicited from students and mentors were based on the following criteria:

A. Student work demonstrates consistently excellent scholastic performance; thorough comprehension; ability to correlate the material with other ideas, to communicate and to deal effectively with course concepts and new material; reliability in attendance and attention to assignments.
B. Student work demonstrates superior scholastic performance overall, reliability in attendance, and attention to assignments; may demonstrate excellence but be less consistent than the work of an A student.
C. Student work demonstrates satisfactory performance overall, as well as reliability in attendance, and attention to assignments.
D. Student work demonstrates minimal, barely passing performance overall; limited knowledge of subject matter.
F. Student work demonstrates unsatisfactory performance and comprehension or unfulfilled requirements. The grade is failing.

These letter grades were converted to scores based on the scale: A=100, B=85, C=75, D=35, and F=0. These peer and mentor scores are summarized in the histogram shown in Figure 1.

![Peer & Mentor Scores, EE416, Spring 2006](image)

**Figure 1.** Histogram of peer and mentor scores.

These are very high scores (minimum is 85%) showing that all of these students possessed an acceptable ability to function on multidisciplinary teams.

Galena and Emerald students are not included in the Figure 1 data. The instructor observed that the Galena student who finished the semester spent many hours counseling his struggling team members before they dropped the class. The struggling Galena
members showed no animosity toward the remaining Galena student. For these reasons, the instructor concluded that the circumstances resulting in his two Galena colleagues dropping the class were unrelated to his ability to work on a team. The instructor spent many additional summer hours meeting with the Emerald team and observed that they had strong teaming skills. For these reasons, the instructor judged that the Galena and Emerald team members possessed an acceptable ability to function on multidisciplinary teams.

Not only was the teams multidisciplinary but the topics for each team were also multidisciplinary. All seven design projects were broad in nature and cut across many disciplines. Mentors and co-mentors included electrical engineers, a computer scientist, a biologist, and a mechanical engineer. The Sapphire team was exposed to wireless networks, digital systems, and metrology. The Zircon team was exposed to wireless communications, digital systems, antenna theory, and metrology. The Cobolt team was exposed to hydrogen reformers, digital control, plant simulation, and temperature measurements. The Topaz team was exposed to protective relaying, data acquisition, simulation software, and underground cable theory. The Galena team was exposed to electromagnetics, grounding theory, human physiology, and the geology of soil in the Spokane region. The Emerald team was exposed to circuit analysis, simulation software, and hydroelectric dam fundamentals. The Garnet team was exposed to optics, digital systems, and metrology.

(E) Ability to identify, formulate, and solve engineering problems.

Each team of students was required to complete an engineering design project that was completely "open ended". An industry professional acted as mentor and there were several other professionals available as resource persons for the teams (the instructor and a faculty resource person for each team.) An important part of the design project is iteratively applying the steps of modeling, simulation, engineering analysis, and refinement. As part of the design project, each team was required to participate in oral and written progress reports, a poster with working demonstration prototype and a written final report. Guests at the EECS open house attended the poster presentation. An industry judging team evaluated the poster presentations and named the top four posters (this competition included Computer Science design posters as well). The overall student grades for spring 2006 EE416 ranged from A to B showing that all students were clearly able to identify, formulate, and solve engineering problems.

(G) Ability to communicate effectively in written and oral formats.

The instructor made several assignments designed to enhance written and oral presentation skills. EE416 is a "writing in the major" or [M] course and technical writing assignments are integral parts of the class activities. One form of written communication was design and printing of a poster describing their project. The instructor circulated guidelines for the posters and asked students to examine research posters displayed by others on campus. Students received guidelines for their written reports. Students first reviewed their technical writing textbook. Students invited their mentor to edit a draft of their final report. All team members were to proof read the written documents. Grades on written progress reports were in the range 69-95% and on written final reports in the
range 69-100% with four teams receiving 100% on the written final report. Three oral
evaluations were required from each team with each student responsible for 10 minutes
of the oral evaluation. The second oral quarterly evaluation included the team mentor and
their guests. This activity simulated technical meetings that are an important part of the
engineer’s professional career. The ranges of student scores for these three oral reviews
were 10-100%, 50-100%, and 90-100%, respectively. The high range of scores for the
last evaluation shows that students learned from their mistakes and became quite skilled
at oral communications as the semester ended. Another oral communication requirement
was that the teams presented their poster to guests at the EECS open house (April 20).
Showing the demonstration prototype also required oral communication skills. All teams
but Emerald performed well at the poster session. Instructor tutoring during the summer
greatly improved the oral communication skills for the Emerald team. Observations
described in this paragraph indicate that these students have an ability to communicate
effectively in written and oral formats.

(K) Ability to use techniques, skills and modern engineering tools necessary for
engineering practices.

Each team used at least one modern software package in their design work: 1) The
Sapphire team used TinyOS as an operating system for an embedded wireless sensor
network, 2) The Zircon team used VHDL digital circuit simulation software, 3) The
Cobolt team used LabVIEW data acquisition and control software, 4) The Topaz team
used ASPEN OneLiner power system analysis software, 5) The Galena team used
WinIGS grounding software and CAD software, 6) The Emerald team used ASPEN
OneLiner power analysis software, and 7) The Garnet team used SPICE circuit
simulation software.

V. Qualitative Assessment of Student Performance: using the arguments above and
other data support the claim that students who completed this course with a grade
of C or better have achieved each of the intended outcomes of this course.

Scores on the final written reports and the poster session presentations (including
the demonstration prototypes) show clear evidence that each team has shown the ability
to 1) design a system, component, or process to meet desired needs, 2) function as a
multidisciplinary team, 3) identify, formulate, and solve engineering problems, 4)
communicate effectively in written and oral formats, and 5) use techniques, skills and
modern engineering tools necessary for engineering practices. The instructor conducted
oral evaluations (and inspected individual student lab books) three times during the
semester with each student. These evaluations insured that each student was contributing
effectively to the team and thus that the individual students had these same abilities. This
semester presented special circumstances with the Emerald and Galena teams; however,
many extra summer contact hours with the two Emerald students gave confirmation that
they each had these abilities. The fact that the Galena student finished the project on time
with respectable scores shows that he also possessed these abilities. While teaming skills
are an essential part of EE416, it is essential that the instructor partition the evaluations so
that there are sufficient evaluations of the individual students.
VI. Concerns: state any concerns you may hold about this class — were the students adequately prepared coming into it? Are there topics or outcomes where (some) students were weak after completing the course? Other concerns? Were there any comments on students’ course evaluations that should be addressed in future instances of the course? This section is very important for improving our program: it provides critical input to the curriculum committee for identifying areas requiring attention.

Students who drop either EE415 or EE416 disrupt the teams and leave a poor impression with sponsoring companies and institutions. The fact that three students dropped the course suggests that some “immature” students registered for the EE415/416 sequence. Since EE415 is a prerequisite for EE416, it is logical to control EE416 enrollment by adjusting the EE415 prerequisites. The syllabus for EE415 should list prerequisites that allow only “properly prepared” seniors to take EE415/416. Some weak students might have senior status before they are certified and/or before they have completed important 300 level classes. Both electrical engineering and computer engineering students take EE415/416. A logical way to make this addition to the list of EE415 prerequisites would be “must have completed with a grade of C or better all required 300 level electrical engineering and computer science courses.”

It is important that EE415/416 instructors keep team sizes greater than three. Teams of three students should not be allowed because one student dropping the class causes great disruption to the teaming process. If there is an odd number or students then one team should have five students not three students.

On the course evaluation form, a student asked that EECS dedicate additional resources to EE416, especially access controlled rooms and computer labs. That student was aware of project tampering due to a lack of access control in the project areas.

Signature __________________________ Date: __________
Please email a copy of the completed form to Patricia Arnold, patricia@eecs.wsu.edu and deliver a signed hardcopy to her mailbox.