Washington State University  
School of EECS  
Electrical Engineering Course Assessment Report

Course Number  EE 352  
Course Title  Electrical Engineering Laboratory  
Semester Offered Spring 2007  
Instructor  Hanshaw  
10th Day Enrollment 20  Number Completing Successfully (C grade or better) 20

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 life long 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. Laboratory and equipment familiarization  
2. Operational Amplifiers – characteristics and filters  
3. Diode characteristics, PSPICE, and circuits  
4. BJT characteristics, model and circuits  
5. MOSFET characteristics and circuits  
6. Circuit analysis: steady state and transient behavior of RLC networks, frequency response  
7. Design project
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>(A) Ability to apply knowledge of mathematics, science and engineering.</td>
<td>1-7</td>
<td>Laboratory assignments, pre-labs, and <strong>final design project</strong> require application of math and science concepts.</td>
</tr>
<tr>
<td>(B) Ability to design and conduct experiments as well as analyze and interpret data.</td>
<td>2-7</td>
<td>All lab assignments require students to acquire and analyze experimental data. <strong>Final design project</strong> requires students to design experiments necessary to characterize the system.</td>
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<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>7</td>
<td>Several lab assignments require simple design projects; <strong>final design project</strong> requires an in-depth, top-down design based on specifications provided by instructor.</td>
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<tr>
<td>(D) Ability to function on multidisciplinary teams.</td>
<td>7</td>
<td><strong>Final design project</strong> required knowledge of mechanical subsystem.</td>
</tr>
<tr>
<td>(G) Ability to communicate effectively in written and oral formats.</td>
<td>2-7</td>
<td>Most laboratory assignments required demonstrations to TAs and written reports. <strong>Final project</strong> required a short (10-15 minute) informal presentation and a formal written project report.</td>
</tr>
<tr>
<td>(J) Have a broad education and knowledge of contemporary issues.</td>
<td>2-7</td>
<td>Students are exposed to a wide range of electronics-related topics; <strong>final design project</strong> required design of robotic subsystem.</td>
</tr>
<tr>
<td>(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>2-7</td>
<td>Most laboratory assignments and especially the <strong>final project</strong> require use of typical laboratory bench equipment (oscilloscope, function generator, etc.) and computer analysis tools (PSPICE, MATLAB).</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.

Successful completion of all outcomes was evaluated based primarily on the final class project; individual laboratory assignments performed throughout the semester primarily functioned as vehicles to introduce specific topics which were necessary for successful completion of the final design project. The project this semester consisted of design and implementation of a robotic system. The overall system consisted of a line-following robot. A robotic subsystem, consisting of a wheeled chassis, DC motors to independently drive the robot’s wheels, on-board battery power supply, and two sets of infrared (IR) sensors to detect light and dark regions was provided for the students’ use. Students were required to design and implement a circuit to control the voltage provided to the DC motors in order to move the robot along the line. Voltages from the IR sensors will be used as inputs to the students’ circuit to indicate the position of the line being followed.

Nominally, students worked in groups of two during the design project.

Results:

The previously listed course criteria and the way in which they are addressed in the final project are discussed below.

(A) An ability to apply knowledge of mathematics, science and engineering:

Overall, the majority of students displayed an adequate ability to apply concepts learned during the course. Some students, however, had difficulty applying concepts learned in pre-requisite and co-requisite courses.

(B) Ability to design and conduct experiments as well as analyze and interpret data:

All lab assignments required students to conduct experiments, gather, and interpret data. Several lab assignments required students to design circuits to perform a specified task; generally, in the laboratory assignments, the design objectives were closely related to current course material. The final project allowed students more latitude in the experiments they performed; in general, it was entirely up to the students to design and conduct any experiments they deemed necessary to perform the design process at hand and demonstrate that the resulting design met requirements.

As expected, few students had little difficulty conducting experiments with instructions which outlined step-by-step approaches to building a circuit and acquiring data. Design tasks contained within individual lab assignments gave the students only slightly more difficulty, probably because of the focused nature of the problem. As expected, the design project, though not difficult, gave the students the most difficulty. This was primarily due to the fact that the students needed to identify and formulate a problem with relatively little guidance. The students’ response to the wide latitude in possible
approaches varied considerably; most students approached the problem in an organized manner and designed experiments necessary to characterize the system and perform an organized, top-down design based on the acquired data. Other students, however, tended to avoid acquiring data until after implementing their design. This latter approach generally resulted in very marginal designs with sporadic success. On a positive note, most students attempting this design-first-test-later approach realized by the end of the project that it was a poor design practice and should be avoided in the future.

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

The final project required students to design the electronics necessary to create an analog line-following robot. Students displayed varying levels of ability in their overall design process and analysis methods. Most students were able to design and implement a system which caused the robot to follow the given course; some designs, however, were extremely marginal and required several attempts to complete the course.

(D) *Ability to function on multidisciplinary teams*

Students in the class are all electrical engineering students. The multidisciplinary aspect of the class was incorporated in the final design project. The project included a significant mechanical system component. The instructor acted as mechanical engineer for all groups and performed in a role which would typically be held by a mechanical engineer in a multidisciplinary team. This role included providing information relative to operation of the IR sensors and DC motors contained in the chassis subsystem. The instructor also provided “hints”, when requested, for approaches for characterizing these components.

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

Individual lab assignments required submission of a lab report; this resulted in submission of seven semi-formal reports over the course of the semester. These lab reports were not stringently graded, the overall idea was to give students some practice in organizing their results prior to submission of the final, formal design project report. Grading criteria for these reports were explicitly provided. In general, performance on the individual lab reports was good.

Performance on the final design project report was mixed. Some students did an outstanding job of organizing and presenting their results, others displayed poor writing abilities.

The final design project submission also required students to informally present and demonstrate operation of their circuit to the instructor. Most students demonstrated adequate communication skills, at least in this informal setting.
(J) Have a broad education and knowledge of contemporary issues

The final design project introduced students to some basic issues in the field of robotics. A brief introduction to the concept feedback control was provided, as were the basics of IR sensor operation. Although both of these topics are somewhat beyond the scope of the course, most students were able to grasp the salient points and use them in their design approach.

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

The final project required a significant level of analysis, including simulation of their overall closed-loop control system. Students were allowed to choose either MatLab or PSPICE to simulate their systems. Students almost invariably chose PSPICE to simulate the overall system, probably because most designs included several transistors, which students perceived to be simpler to model in PSPICE.

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.

Overall, the students’ performance was good. The average score on the laboratory assignments was very high, at approximately 91%. The average for the final project report was 78%, significantly above the 70.7% average for the final report for Fall 2006. Part of the difference in scores for the final project may be due to a decreased level of difficulty in the Spring 2007 final project; many students were able to meet the project requirements with a simpler circuit than had been anticipated by the instructor. Overall, the students’ performance was adequate relative to the ABET criteria listed above.

The students’ proficiency with MatLab and PSPICE was, in many cases, lower than expected.
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 were, in general, adequately prepared for the class before entering it. Some deficiencies were noted in their abilities to use engineering analysis tools such as MatLab and PSPICE. Many of the skills associated with basic use of these tools were overcome during this class. This shortcoming is consistent with observations made in previous semesters.

Many students had very poor writing abilities when coming into the class. For the most part, these skills were enhanced significantly during the class, but a number of students still displayed inadequate writing capabilities in their final project reports.

The final project this semester was probably slightly too simple. A number of students were able to use poor design methods but still create a functioning device. Most of these students realized at some point during the design process that their approach was leading to a poor design, but at this point it was, in general, too late for the students to alter their approach.

Students need more exposure to design problems in this class and other concurrent classes.

This course’s ability to satisfy ABET criteria (D) – ability to function in multidisciplinary teams – is marginal at best. Typically only electrical engineering students take this class.

Signature __________________________________________ Date: _______________________


