Washington State University  
School of EECS  
Electrical Engineering Course Assessment Report

Course Number  EE 476  
Course Title  Analog Integrated Circuits  
Semester Offered Fall 2008  
Instructor  La Rue  
10th Day Enrollment 12  Number Completing Successfully (C grade or better) 11

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. Introduction to mixed analog/digital microelectronics.  
2. Operation of MOS transistors including large- and small-signal modeling.  
4. Design of MOS operational amplifiers with emphasis on large-signal characteristics, analysis of open loop gain.  
5. Frequency response of amplifiers.  
7. Noise and feedback.
### 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>2 - 7</td>
<td>Most homework, quizzes and exams</td>
</tr>
<tr>
<td>(B) Ability to design and conduct experiments as well as analyze and interpret data.</td>
<td>3 - 7</td>
<td>SPICE related HW 6, 8 and 9 Project</td>
</tr>
<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>3 - 7</td>
<td>Project HW 21, 22 and 29 Quiz 7 Exams 1.2, 2.1 &amp; 3.1</td>
</tr>
<tr>
<td>(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>2 - 7</td>
<td>Project Quizzes 5,6,7,8,9 Exams: 1.2, 2.1-2.4, 3.1-3.3 Final 1-4</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.

(A) Ability to apply knowledge of mathematics, science and engineering.

The entire course involves the application of mathematics to analyze and design amplifier circuits and determine their performance parameters. The underlying behavior for transistors is the physics of the device. This ability can be assessed by the students’ overall average.

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

Students use SPICE to simulate circuits and learn to analyze and interpret the results to obtain the circuit parameters.

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

The project consists of designing an op-amp to meet about a dozen specifications and is the major assessment tool for this outcome. However, many homework, quiz and exam questions include design related questions.

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

Students use SPICE simulations extensively in this class to design and analyze circuits. Techniques used in this class include small signal analysis, zero value time constants and Miller’s theorem.
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.

Assessing Outcomes A and K are based on the overall average since the project and most homework, quiz and exam problems relate to this ability. Figure 1 shows a histogram of the final weighted averages for the 5 students. Four students had an overall average less than 70%. Two of these students were at 69%.

![Histogram of overall weighted average](image)

Figure 1. Histogram of overall weighted average

The primary educational outcome for this course is outcome (C), an ability to design a system, component or process to meet desired needs. In addition to design related problems in homework, quizzes and exams, which account for about 10% of the overall score, this course has for a project to design an op-amp, which accounts for an additional 10% of their overall score. In order to complete this project, the students need to apply most of the knowledge that they gain in the lectures. The students are given SPICE transistor models and about a dozen op-amp specifications and are expected to design an op-amp to meet the specifications. This project is similar to a project that the students might encounter in industry, where they need to design an IC component to specifications. Unlike an industry project, they do not need to simulate it over temperature, supply and process corners since they do not have enough time to verify the design completely. Most students did well on the project.

Outcome B is assessed with the project score and all students who passed did well enough to show this ability. The average project score excluding the failing student’s
score was 85%. The lowest score of the passing students was 68%, which was the only passing student with a score under 70%. This was from a very good student who ended up with an A in the class and I guess that it was because a high grade was not required and he did not spend much time on it.

The undergraduate enrollment was back up this year compared to 5 last year and 10 and 11 the previous two years before that. Three people (27%) scored higher than 80% on the final this year versus 40% last year and 10%, 36% and 31% in the previous two years before that. If the two students who had a score of 78%, had done a little better the percentage over who scored at least 80 would have been 45%. The average final exam score was 68%, which is about the same as the previous year averages of 72%, 65%, and 73%. Average exam scores were 77% compared to 79%, 76%, 75% and 79% the previous years respectively. The average quiz scores of 85% compared to 82%, 83%, 85% and 82% the previous four years.

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.

This year I again spent more time on frequency response, especially Bode plots in an attempt to raise scores on the 3rd exam, which typically has lower scores. I also gave more examples. Average scores on the exams were 76%, 84% and 71%.

The first exam usually has high scores and this year was somewhat lower. Scores on the second exam in the previous 3 years were 77%, 81% and 91%. This year was higher that the last 2 years.

The third exam covers frequency response of opamps and the exam scores usually drop significantly from the first two exams. Scores for the previous years were 73%, 66%, 53% and 74%. This year’s 71% is about the same as last year and is nearly back to the average of 4 years ago. Continuing to spend more time on frequency response as I did the last two years is recommended.

Signature ______________________ Date: __8/31/2009________

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