Washington State University  
School of EECS  
Electrical Engineering Course Assessment Report

Course Number  EE 476  
Course Title  Analog Integrated Circuits  
Semester Offered  Fall 2005  
Instructor  La Rue  
10th Day Enrollment  11  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 (Samples should be available in the course materials file for inspection.)</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>(H), (I), and (J)</td>
<td></td>
<td>None</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.

(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.
There are no specific measures of these three outcomes in this course. It is recommended that these outcomes be removed from the syllabus for EE476.

(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 11 students. Everyone’s overall average was greater than 70%.

![Overall 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. Three students did poorly because they did not allocate enough time to complete the project.

Outcome B is assessed with the project score and all students did well enough to show this ability.

There were 11 undergraduates this year compared to 13 and 16 the previous two years. Four people (36%) scored higher than 80% on the final this year versus 31% last year, and 6% and 43% in the previous two years before that. The average final exam score was 73%, up from 70% the year before and 61% and 71% the two years before that. Average exam scores were about 75%, compared to 79%, 70% and 80% the previous years respectively. The average quiz scores of 85% were the same as last year and compare to 82% and 79% the previous two 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 increased the time spent on single stage and differential amplifiers with emphasis on problem solving. Scores on the second exam was high at 91% compared to 81% last year.

Last year I increased the time spent on frequency response of opamps and reduce time spent on the effects of loading on opamps. This year I did the same but scores on the third exam dropped to 53%, compared to 74% last year. There is usually a drop between the first two exam scores and third exam but usually only 7% to 12%. I am not sure why this happened but maybe the exam was harder this year. I will watch this closely during next year’s course.

I assign 2 problems of homework each class that was due the next class. This forces the students to keep up with the material. Students appreciate the homework being assigned this way, saying that it does force them to keep up.

I recommend that we remove outcomes (H), (I) and (J) from the syllabus for EE476.

Signature __________________________________________ Date: _______________________

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