Washington State University  
School of EECS  
Electrical Engineering Course Assessment Report

Course Number  EE 477  
Course Title  Analog Integrated Circuits Lab  
Semester Offered Spring 2007  
Instructor  La Rue  
10th Day Enrollment 10  Number Completing Successfully (C grade or better) 6

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. Equipment familiarization.  
2. MOS transistor characteristics and parameter extraction  
3. Operational amplifier characterization.  
4. High-speed measurements.  
5. Automated instrument control.  
7. MOS transistor layout design rules and models.  
8. Integrated circuit design project. The students design, simulate and layout an analog integrated circuit and write a formal report.

III. Course Assessment Summary Table: one row of the table should be devoted to each of the checked outcomes in part I.
### Outcome Topics

| Specific Measures (Samples are be available in the course materials file for inspection.) |
|---|---|
| (A) Ability to apply knowledge of mathematics, science and engineering. | 2 - 8 | Labs 2, 3, 5 and 6 |
| (B) Ability to design and conduct experiments as well as analyze and interpret data. | 3 and 6 | Lab Report 2 and Lab 5 |
| (K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices. | 4, 5, 6 and 8 | Lab Reports 3, 5, 6 and Mini-project |

### 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.

Labs 2, 3, 5 and 6 cover characterization of op-amps, automating data measurements using GPIB, transmission line measurements and characterizing DACs respectively. These require using knowledge of transistors, op-amps, transmission lines and analyzing data. This ability can be assessed by the students’ average of 87% on these 4 labs. The lowest score was 60%, which was due to lack up time writing the report. The student completed the measurements in the lab. The next lowest score was 70%. Thus, students showed proficiency in this ability.

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

Lab 2 covers characterization of many op-amp parameters. Experimental setup is sometimes challenging with the equipment provided. The measured data needs to be interpreted and analyzed correctly to determine the op-amp parameters. Lab 5 covers measurements of reflections from opens and shorts on transmission line stubs. The frequencies for the measured minimum and maximum amplitudes can provide the electrical length of the stub and can be compared to theory. The average scores were 84% on these 2 labs, which shows that the students had this ability. In lab 5 however, the students did not calculate the stub length and compare the results with theory as I had asked. I will emphasize this analysis more in the lab instructions next time.

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

Students learn to use manual IC probers, RF and manual wafer probing of ICs, sampling scopes, and spectrum analyzers. They learn to control instruments using GPIB and use printed circuit board layout tools. They learn techniques to measure op-amps, DACs and ADCs. Labs 3, 5, 6 and the Mini-project to lay out a printed circuit board are the best measures for assessing this outcome. The average score was 89% for these lab reports, showing good abilities.
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.

The overall average for the course was 89% for the 6 students who completed this course. There were 4 A’s and 2 B+’s.

All the students participated in the labs. Occasionally a student would not contribute much one week to their team, but I noticed other weeks that they were leading the effort. I think that all of the students learned quite a bit about different high-performance test equipment and how to test some complex ICs, like DACs, ADCs and op-amps. I did notice that the students were not quick at programming in C/C++ and the labs took longer than planned partially because of this. They were successful in getting the programs to work, however. Because of this and equipment problems, which also slowed things down, the project had to be shortened to designing a very simple 2-layer printed circuit board. Although this provided them with an introduction to PCB layout, they did not have the opportunity to lay out a more complex 4-layer board and use ground and power planes.

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.

Many new lab assignments were introduced this year to provide the students a rich experience in testing integrated circuits using high-performance equipment and automating the measurements. A big problem was with the PCs that control the instruments over GPIB. Two computers died during the course and it took a while to get replacements up and running and these were old and slow. Next time we should have a couple of spare PCs loaded with the correct software on standby. Things like this always seem to go wrong when testing and so this did provide them with real-world experience.

Another issue was that the course was not scheduled in advance when the students registered but by arrangement. We could not find a 3 hour stretch of time that everyone could meet for the lab. We ended up having a 4 hour stretch of time where everyone had 3 available hours and some students would leave and come back. This caused some students to miss parts of the lab and in the future the lab should be scheduled before hand.

The labs took longer than planned for various reasons. There were 6 weeks planned at the end for a project, which was shortened to 2 weeks as several labs took an extra week. Next time I suggest streamlining some of the labs to save the lab from spilling over an extra week. Removing Lab 7 characterizing an ADC altogether can provide an extra 2 weeks for the project. This lab is very similar to Lab 6 measuring a DAC. Another alternative is to provide more of the programming code for both Lab 6 and Lab 7 to insure that they only take 3 weeks between them.

We need to have more than 2 lab stations if we are to have more than 6 students. Most labs had only two sets of equipment. Luckily there were only 6 students in the course so that there were two teams of 3 students. The first lab had 11 students on two sets of equipment and this limited their experience. We had three stations for Lab 3. Labs 4 and 5 have only one set of high-performance equipment but these have two experiments each
so two groups can work simultaneously. Lab 4 and Lab 5 could be run simultaneously, with 2 groups doing Lab 4 and 2 other groups doing Lab 5. The groups could then switch the next week. Lab 6 and 7 could be modified to have 4 stations if we add two more PCs.

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.