Washington State University
School of EECS
Electrical Engineering Course Assessment Report

Course Number: EE 431
Course Title: RF and Microwave Circuits and Systems
Semester Offered: Spring 2007
Instructor: Deuk Heo
10th Day Enrollment 28  Number Completing Successfully (C grade or better) 26

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 use techniques, skills and modern engineering tools necessary for engineering practices.

II. List of Course Topics from the Course Syllabus
   1) Waves on Transmission Lines.
   2) Smith Chart.
   3) Impedance Matching Networks.
   4) S parameters and Microwave Network Analysis.
   5) RF Filters.
   6) Noise Figure and Noise Temperature.
   7) Nonlinearities, Intermodulation, Dynamic Range and IP3.
   8) RF amplifier Design and Gain Circles.
   9) Bias Networks.
   10) Low Noise Amplifier Design and Noise Circles.
   11) RF Mixers.
   12) Voltage Controlled Oscillators.
   13) Phase Locked Loops.
   14) Transceiver Architectures.

III. Course Assessment Summary Table: at least one row of the table should be devoted to each of the checked outcomes in part I. The measures shown with bold emphasis will be used for this course as examples in Outcome Assessment folders.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Topics</th>
<th>Medium</th>
<th>Special Measures</th>
<th>Weight in Course</th>
<th>Instructor’s assessment and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1-14</td>
<td>Homework</td>
<td>Homework 1-10</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exam and Quiz</td>
<td>Exam 1-3, Final exam</td>
<td>60%</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Lab report 1-10</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1-8, 10-11</td>
<td>Exam and Quiz</td>
<td>Exam3, Final</td>
<td>25%</td>
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<tr>
<td></td>
<td></td>
<td>Lab</td>
<td>Lab report 1-10</td>
<td>20%</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>3-12</th>
<th>Homework</th>
<th>Homework 4, 7-10</th>
<th>10%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Exam and Quiz</td>
<td>Exam1-3, Final exam</td>
<td></td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Lab report 4-6, 8-9</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

| K   | 1-5, 7-8, 10-11, 14 | Lab | Lab report 1-10 | 20% |

IV. 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.

Outcome A: Ability to apply knowledge of mathematics, science and engineering.
All the homeworks, quizzes, exams and lab reports were related to this outcome, therefore, I feel the final grade can be a reasonable measure of this outcome. There were seven (7) “A”, twelve (12) “A-”, five (5) “B+”, two (2) “B-”, and two (2) “C+” grades. The lab components cover both circuit design and hands-on measurement experience to learn how to apply their knowledge of mathematics, science and engineering to RF and microwave circuit and system problems. The class averages in Midterm1, 2, 3 and final were 93, 81, 83, and 80 respectively out of 100 showing a good performance by the class. Homework, quizzes and exams were also designed for measuring this ability and the final grade showed this class satisfies the requirement of ABET 3(A).

Outcome B: Ability to design and conduct experiments as well as analyze and interpret data.
My assessment of criteria 3(B) is based on my observations while supervising the labs and the average of the lab 1-10 report and exam3 and final. About two third of the students demonstrated an ability to perform experiments effectively in an laboratory. The rest required some help from myself and TA to perform the measurement and analysis of the measured data. In their lab reports, most of students were able to analyze and interpret the data. The average of the lab report and exam3 is 95, and 83 respectively out of 100. The averages showed that all students clearly understand the purpose of the lab and how they analyze the measured data.

Outcome C: Ability to design a system, component, or process to meet desired needs.
My observation of critera3(C) is based on homework 7-10 and lab 1-10. Lab reports and homeworks showed that all students clearly understand the system dynamic range, sensitivity, linearity of overall wireless communication systems. In addition, students could design a simple RF sub components including amplifier, filters, and mixers for wireless receiver design.

Outcome K: Ability to use techniques, skills and modern engineering tools necessary for engineering practices.
My assessment of criteria 3(K) is based on lab reports 1-10. Most of the students demonstrated an ability to use techniques, skills and modern engineering tools necessary for engineering practices. The rest required some help from TA to perform the measurement and analysis of the measurement data. For software lab, they were asked to use modern CAD tools such as ADS
from Agilent. In addition, students used network analyzers for S-parameter measurement and spectrum analyzer for amplifier, mixer and receiver measurement.

**OVERALL AVERAGE AND GRADES REPORTED**
The class started with 28 students and 28 students took the final examination. Weekly homework assignments and quizzes were given to students on Friday class and the homework due was the following Friday. Three midterm examinations and final examination were given to students in the semester and the averages were 94, 80, 83, 86 and 80 respectively. The attendance in the class was usually more than 90%. The final examination was used as an assessment tool of student’s performance. There were seven (7) “A”, twelve (12) “A-”, five (5) “B+”, two (2) “B-”, and two (2) “C+”, grades in the class.

**FINAL OBSERVATION**
Majority of the students did very well in the class based on the final grade. Seven students got A, and twelve students got A-. All 28 students completed all the requirements for the class.

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.