Washington State University
School of EECS
Electrical Engineering Course Assessment Report

Course Number  EE 432
Course Title  RF Engineering for Telecommunications
Semester Offered  Fall 2006
Instructor  Ben Belzer

10th Day Enrollment  19  Number Completing Successfully (C grade or better)  19

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. Radiowave propagation.
2. Empirical propagation models and link budgets.
3. Multipath and fading.
4. Diffraction and computer propagation tools.
5. Cellular concept, frequency reuse, and queuing theory.
6. AM, SSB, and FM.
7. Digital modulation.
8. Spread spectrum.
10. Encryption, Equalization
11. Channel and source coding.
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>1-11</td>
<td>Homeworks 1-10, midterms, final exams (in-class and take-home), Quizzes 1-5, Labs 1-10</td>
</tr>
<tr>
<td>(B) Ability to design and conduct experiments as well as analyze and interpret data.</td>
<td>1-4, 6-7, 11</td>
<td>Labs 1-10, Final exam (take-home)</td>
</tr>
<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>4, 7, 11</td>
<td>Homework 4, Labs 9-10, Take-home final</td>
</tr>
<tr>
<td>(I) Recognize the need for, and have the ability to engage in lifelong learning. (EE432 Syllabus: Understand wireless telecommunication technology, market and technology trends.)</td>
<td>5-9</td>
<td>Homeworks 5-9, Quizzes 3-5, midterms, final exams (in-class and take-home).</td>
</tr>
<tr>
<td>(J) Have a broad education and knowledge of contemporary issues. (EE432 Syllabus: Understand wireless telecommunication technology, market and technology trends.)</td>
<td>5-9</td>
<td>Homeworks 5-9, Quizzes 3-5, midterms, final exams (in-class and take-home).</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.

For Fall 2006 EE432, the average homework score (for homeworks 1-10) was 90.6%; average score on the midterms (in-class and take-home) was 72%; average score on the final exams (in-class and take-home) was 70%, the average quiz score over quizzes 1-5 was 64%, and the average lab report score over labs 1-10 was 92%. (Maximum possible score is 100% in all cases.) These assignments asked students to apply various topics from mathematics, science and engineering (e.g., electromagnetic propagation, probability theory, queuing theory, communication theory,) to analyze and design cellular communication systems. These scores indicate that, on average, the students achieved outcome A.

(B) Ability to design and conduct experiments as well as analyze and interpret data.
For Fall 2006 EE432, the average lab report score over labs 1-10 was 92%, and the average score on the take-home final was 69.8%. (Maximum possible score is 100% in all cases.) These assignments asked students to conduct experiments, and to analyze and interpret data. In some cases (labs 9-10, the take-home final), the experiments were Monte-Carlo computer simulations. These scores indicate that, on average, the students achieved outcome B.

(C) Ability to design a system, component, or process to meet desired needs.
For Fall 2006 EE432, the average homework 4 score was 95%; the average score over labs 9 and 10 was 89.5%, and the average score on the take-home final was 69.8%. (Maximum possible score is 100% in all cases.) These assignments asked the students to design computer programs for diffraction gain computation from a topographical database (homework 4), simulation of non-coherent FSK transmission and reception in additive white Gaussian noise (labs 9 and 10), and simulation of a multi-user frequency-hopped spread spectrum system, with and without error correction coding (take-home final). These scores indicate that, on average, the students achieved outcome C.

(I) Recognize the need for, and have the ability to engage in life long learning. (EE432 Syllabus bullet for item (I): Understand wireless telecommunication technology, market and technology trends.)
By helping students understand the theory behind technologies used in past, current, and future cellular telephone standards, and by summarizing historical and future standards in lectures, EE432 helps students realize the need for life-long learning in order to keep up-to-date on cellular telecommunication technologies and standards. For Fall 2006 EE432, the average homework score over homeworks 5-9 was 85.2%; the average score over quizzes 3-5 was 59%; average score on the midterms (in-class and take-home) was 72%; and the average score on the final exams (in-class and take-home) was 70%. (Maximum possible score is 100% in all cases.) These assignments required students to understand wireless communication technologies used in past, current and future wireless communication standards, and to understand wireless communication market issues and technology trends. These scores indicate that, on average, the students achieved outcome I.

(J) Have a broad education and knowledge of contemporary issues. (EE432 Syllabus bullet for item (J): Understand wireless telecommunication technology, market and technology trends.)
For Fall 2006 EE432, the average homework score over homeworks 5-9 was 85.2%; the average score over quizzes 3-5 was 59%; average score on the midterms (in-class and take-home) was 72%; and the average score on the final exams (in-class and take-home) was 70%. (Maximum possible score is 100% in all cases.) These assignments required students to understand wireless communication technologies used in past, current and future wireless communication standards, and to understand wireless communication market issues and technology trends. These scores indicate that, on average, the students achieved outcome J.

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.

To achieve a C or better in Fall 2006 EE432, a student needed to achieve an average overall course score of at least 60%. The components and weighting of the overall course score were: ten homeworks with a total weight of 10%, ten labs with a total weight of 35%, five quizzes with a
total weight of 20%, and four exams with a total weight of 35% (in-class midterm, take-home midterm, in-class final, and take-home final.) For each student, the lowest scoring paper from each of the above four categories (homework, labs, quizzes, and exams) was dropped in computing the overall course score. The average overall course score for Fall 2006 EE432 was 82.4%, and the lowest overall course score was 62.3%. These overall course scores indicate that all students achieved competency in the course material at a level above the minimum requirement for a C grade.

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.

By and large, students were adequately prepared for this course. I believe that having probability as a formal prerequisite, which will commence in Fall 2007, will help to strengthen students’ preparation for this course. One student commented on the need for more depth in the course. The instructor believes that this concern can be partially addressed by going into more depth on digital communication topics important for wireless, which are not covered in other WSU undergraduate courses. Examples of such topics are: pilot-symbol aided modulation (PSAM) for phase tracking on fading channels, used in current digital cellular communication standards, and orthogonal-frequency-division-multiplexing (OFDM), which will be used in future cellular standards. A minor curriculum change is planned for Fall 2008 to accommodate these additional topics.

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.