Washington State University
School of EECS
Electrical Engineering Course Assessment Report

Course Number  EE 341
Course Title  Signals and Systems
Semester Offered Spring 2007
Instructor  B. Belzer
10th Day Enrollment 29 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 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 lifelong 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. Classification and properties of signals and systems.
2. Discrete and continuous-time impulse response, convolution, differential and difference equations.
3. Fourier representation of discrete and continuous-time signals.
4. Frequency response of LTI systems, sampling and reconstruction, DFT.
5. Introduction to filter design.
6. Amplitude modulation.
7. Angle modulation (FM and PM).
8. Information, entropy, and Huffman codes.

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>1-8</td>
<td>Homeworks 1-14, Computer Assignments 1-3, Midterms 1-3, Final Exam. Specific Examples: Midterm 1 Probs. 1, 3; Midterm 2 Probs. 1, 2; Midterm 3 (all problems); Final Exam (all problems).</td>
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<tr>
<td>Understand the concept of a system and basic system properties. Understand the analysis of linear time-invariant (LTI) systems using convolution. Learn Fourier representations of signals and apply them to the analysis of LTI systems. Understand the effect of sampling an analog signal in the frequency domain and its implications to digital signal processing. Understand the concept of modulation (AM, FM, PM) in communication systems. Understand elementary concepts in information theory</td>
<td>6, 8</td>
<td>HW 8, Comp. Assign. (CA) 2, HW14, Final Exam Problem 5. Specific Examples: HW8, CA2, Final Exam Problem 5.</td>
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<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>2, 3, 5</td>
<td>CA1, CA2, CA3, HW8 Specific Examples: CA1, CA3</td>
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<tr>
<td>Can design simple frequency selective filters based on Butterworth polynomials.</td>
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<td>Can construct a Huffman code given a symbol frequency table.</td>
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<tr>
<td>(K) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
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<tr>
<td>Ability to use computer tools (Matlab) to design filters and enhance understanding of the underlying concepts</td>
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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 course starts with an introduction to basic system properties and examples, followed by a thorough analysis of continuous-time LTI systems using the convolution equation. The course then covers exponential Fourier series and the Fourier Transform representation. Midterm 1 (and the associated HW exercises 1-5, and computer assignment (CA) 1) focussed on this material. The average midterm 1 score was 60%.

Applications of the Fourier Transform, including frequency response of LTI systems, sampling, and an introduction to filter design formed the second part of the course. Midterm 2 (and the associated HW exercises 6-8, and CA2) focused on this material. The average midterm 2 score was 66%.

Discrete-time LTI systems, including discrete-time convolution and the discrete-time Fourier Transform, were covered in the third part of the course. AM modulation techniques were also covered, and contrasted in terms of power and bandwidth requirements, and receiver design. Midterm 3 (along with associated HW exercises 9-12, and CA3) focused on this material. The average midterm 3 score was 61%.

FM communication was covered in the last segment of the course, with an emphasis on deriving the spectrum and bandwidth assessment. Also presented was a brief introduction to information theory followed by Huffman codes, with an emphasis on using symbol probability information to design more efficient variable length codes. The final exam (specifically, problems 4 and 5) tested this material, as well as earlier material presented in the course. This material was also covered in HW13 and HW14. The average final exam score was 60%.

The average HW score (across HW1-HW14) was 77.5%, and the average computer assignment score (across CA1-CA3) was 91%.

Based on these performance metrics, the instructor can make a reasonable conclusion that, on average, students have demonstrated an ability to apply knowledge of mathematics, science and engineering.

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

Principles of Analog filter design with specific emphasis on design of Butterworth filters (see topic 6) is covered right after covering Fourier transforms (and its applications). The instructor provided detailed notes for this topic. Design equations for Butterworth filter design (obtaining filter order and 3dB frequency) are derived. Expression for the filter transfer function based on an analysis of the pole locations is
also derived. Design of Huffman codes as a variable length encoding scheme is introduced.

HW 8 asks students to design a Butterworth filter from a given set of specifications, and CA2 asks students to plot the frequency and phase response of their design and verify that it meets the specs. CA2 also asks students to design a simple notch filter, first using only an all-zeros transfer function, and then using a transfer function with both poles and zeros. HW 14 has two problems on Entropy and design of Huffman codes, and the final exam problem 5 also covers Huffman code design.

Students averaged 86% on HW 8, 94% on CA2, 85% on HW14, and 95% (19/20) on problem 5 of the final exam. Based on these performance metrics, the instructor can make a reasonable conclusion that, on average, students have demonstrated an ability to design a system, component, or process to meet desired needs.

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

Matlab was used extensively in the three computer assignments CA1, CA2, and CA3, and also on HW8. CA1 covered convergence properties of exponential Fourier series, CA2 covered Butterworth and notch filter design, and HW8 covered Butterworth filter design. The average score on HW8 was 86%, and the average computer assignment score (across CA1-CA3) was 91%.

Based on these performance metrics, the instructor can make a reasonable conclusion that, on average, students have demonstrated an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
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.

Based on the student performance in the specific HW and Exams (see Section IV for details), the instructor can make a reasonable conclusion that students obtaining a C grade or better have achieve criteria 3(A), (C), and (K), as it applies to EE341.

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.

Some students had weak math skills, which affected them particularly during exams, when time was limited. Also, many students did not appear to be well-practiced in computing convolution integrals. The instructor recommends that enough convolution drill problems be given in EE321 so that students are reasonably well prepared to compute continuous-time convolution integrals by the time they start EE341.

Signature __________________________________________ Date: ___May 16, 2007___

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