Course Number EE 321
Course Title Electrical Circuits II
Semester Offered Spring 2006
Instructor P. Pedrow
10th Day Enrollment: 30 Number Completing Successfully (C grade or better) 25

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. Circuit analysis review
2. State variable analysis of linear systems
3. Laplace Transform, Inverse Laplace Transform
4. Relationship between Laplace domain and time domain, convolution
5. System poles, zeros, eigenvalues and eigenvectors
6. Laplace transform in circuit analysis
7. Transfer function
8. Frequency response, frequency selective circuits, Bode plots
9. Fourier series
10. Fourier transforms
11. Two-port networks
12. Mutual inductance
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</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Ability to apply knowledge of mathematics, science and engineering.</td>
<td>1, 3, 12</td>
<td>Exam 1</td>
</tr>
<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>1, 2, 3, 4, 6</td>
<td>Part I of the EE321 Written Project Report</td>
</tr>
<tr>
<td>(E) Ability to identify, formulate, and solve engineering problems.</td>
<td>1, 7, 8, 9, 10, 11, 12</td>
<td>Exam 3</td>
</tr>
<tr>
<td>(G) Ability to communicate effectively in written and oral formats.</td>
<td>2, 3, 4, 5, 6, 7, 8, 11</td>
<td>Parts I and II of the EE321 Written Project Report</td>
</tr>
<tr>
<td>(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</td>
<td>Section A of Part I of the EE321 Written Project Report</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.

While mathematics, science, and engineering permeate nearly all topics in EE321, Topics 1, 3, and 12 listed in the table are especially pertinent with respect to the students’ ability to apply knowledge of mathematics, science, and engineering. Students studied Laplace transforms and inverse Laplace transforms as mathematical tools in preparation for applying them to transient circuit analysis. Students studied mutual inductance using the science of magnetic coupling (Ampere’s Law) and induced voltage (Faraday’s Law). The class also studied engineering devices closely related to these science topics including the transformer and three phase circuits, both important to electric power engineering. Exam 1 measured student performance on Topics 1, 3, and 12. Subjects listed on the study sheet for Exam 1 that are pertinent to Outcome “A” include: Lenz’s Law, mutual magnet coupling, self inductance, mutual inductance, dot convention for mutually coupled coils, Faraday’s Law, magnetic flux, coefficient of coupling, phasors, ideal transformer, balanced 3 phase circuits, Y and Δ circuit connections, Laplace transforms, inverse Laplace transforms, step functions, delta functions, the sampling property of the impulse, functional Laplace transform pairs, and operational Laplace transform pairs. Figure 1 shows a histogram of Exam 1 scores.
The three lowest scores in Figure 1 are 32, 40, and 57%. It is difficult to argue that these three students had acceptable ability to apply knowledge of mathematics, science, and engineering; however, their course grades were less than a C thus they are required to repeat the class. From the Exam 1 results, all students completing EE321 with C or better grade appear to have suitable ability to apply knowledge of mathematics, science, and engineering.

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

In Part I of the Project, the student designed and used a process that allowed the student to cross check several solution techniques and gave the student confidence in determining when a result “makes sense”. Students iterated between the following solution techniques: SPICE simulation, state space simulation, and Laplace transform techniques. The number of times and the order in which each student utilized these solution techniques was unique to each student. Scores on Part I of the Project are measures of the effectiveness with which the students designed their solution process. Figure 2 shows a histogram of these scores. The two lowest scores in Figure 2 are 0 and 20%. It is difficult to argue that these two students had acceptable ability to design a system, component, or process to meet desired needs; however, their course grades were less than C thus they are required to repeat the class. From the Project Part I scores it is concluded that all students completing EE321 with C or better grade have suitable ability to design a system, component, or process to meet desired needs.
(E) Ability to identify, formulate, and solve engineering problems.

This assessment report interprets “engineering problems” as those related to engineering devices or systems. Typical engineering devices analyzed in this course are transformers, passive filters, active filters, and two port devices which can easily represent communications channels and systems. Engineering devices are spread throughout EE321; however, Exam 3 focused on filters and the frequency content of signals (as determined by Fourier series and Fourier integral techniques.) Thus Exam 3 covers essential topics related to communications systems. It appears logical to claim that a student passing Exam 3 has shown an ability to identify, formulate, and solve engineering problems. Figure 3 shows a histogram of Exam 3 scores.
The 3 lowest scores in Figure 3 are 14, 27, and 44%. As before, it is difficult to argue that these three students had acceptable ability to identify, formulate, and solve engineering problems; however, their course grades were less than C thus they are required to repeat the course. If we consider 60% to be the threshold for competency then students with the following scores give concern: 49, 50, 51, 54, 54, 56, and 58%. Checking the class roster shows that the students with 49% and 51% received less than C for the course thus they must repeat the class. Still troublesome are the students with scores 50, 54, 54, 56, and 58%. These might represent students who passed the course yet had marginal ability to identify, formulate, and solve engineering problems. Course scores for these students were C, C+, B-, B-, and B+, respectively. Other prospective reasons for these students to appear to have weak abilities for Outcome E are: 1) this was the last hourly exam for the semester given on the last Friday before closed week and students were “overloaded” with other course work, 2) the topics of filters, Fourier series, and Fourier transforms are more challenging for the students, and 3) one can hypothesize that the course grading was too lenient and some of these five students should have received a course grade less than C. Future assessment reports should use a different metric for Outcome E. Faculty should review the EE321 syllabus if the new metric gives similar results (students with marginal abilities in Outcome E passing EE321). In summary, this metric showed that 20 of the 25 students passing the course with C or better clearly had the ability to identify, formulate, and solve engineering problems. Five of the 25 students passing the course with C or better showed (via the chosen metric) only marginal ability to identify, formulate, and solve engineering problems.

(G) Ability to communicate effectively in written and oral formats.

Students completed Parts I and II of their EE321 Project. Writing instructions in the Project assignment read in part,

“Use at least 300 words to summarize your results for Parts I and II of this project. Do not repeat comments you have already made in your solutions to the problems. You need not produce new data for this [write up] but merely comment on results you have already produced. Use only paragraphs and complete sentences - no equations, no tables, no bulleted lists, and no figures. Prospective items on which you can comment are: damping conditions (over, under, critical), which techniques are most efficient, which are most difficult, which are most powerful, which were not successful for you (if any), which one of the problems was most rewarding to your learning experience, poles, zeros, residues, initial conditions, maximum observed voltage, maximum observed current, phasor characteristics, two port properties, filter properties, etc.”

There was no oral report component in the Project and from that standpoint, only half of Outcome G (the written format) is covered by EE321. The systems faculty should consider if oral reports must be given on these projects so that the other half of Outcome G (oral format) is addressed. Figure 4 shows the histogram of the combined scores (Parts I and II) for the Projects.
The two lowest scores are 0 and 8 % but these were received by students with a course grade less than C. The remarkable score is the 48 % received by a student who finished the course with a grade of C. The concern here is that a student passed the course without demonstrating a sufficient ability to communicate effectively in written format. A review of this student’s project shows that the written section was very strong but the student had significant problems solving the Part II circuit assignments. For students receiving C or better for the course, grades for the written summary were in the range 80-100 %. With the caveat that EE321 does not provide an oral communication experience for the student, Figure 4 shows that all students passing EE321 with C or better had the ability to communicate effectively in written format.

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

Many homework problems required students to use the modern software packages SPICE and MATLAB. Similarly, several sections within the Project required the use of these simulation tools. Part A in the Project directions reads in part:

“Working with the conditions shown in Table A.1, use the Spice software package of your choice to make plots of 1) generator voltage, 2) capacitor voltage, 3) inductor voltage, 4) capacitor current, and 5) inductor current. Use the same time window for each plot and select that time window such that it clearly shows the approach to sinusoidal steady state yet gives good resolution showing the decaying transient. Turn in a) your hand written analysis, b) hardcopy of your Spice plots, c) hardcopy of your .cir file if you used the .cir-based approach or hardcopy of your schematic if you used the schematic-based approach, and d) at least four typed sentences that describe observations regarding your results.”

For students receiving C or better in the course, scores for Part A of the Project were in the range 70-100 % showing that they were capable of using techniques, skills and modern engineering tools necessary for engineering practices.
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.

Exam and Project scores have supported the hypothesis that students completing EE321 with C or better are suitably equipped to 1) apply knowledge of mathematics, science and engineering; 2) design a system, component, or process to meet desired needs; 3) identify, formulate, and solve engineering problems; 4), communicate effectively in written and oral formats; and 5) use techniques, skills and modern engineering tools necessary for engineering practices. Two notable caveats are i) The metric used for Outcome E suggested that there might have been 5 students only marginally equipped to identify, formulate, and solve engineering problems and ii) EE321 does not currently support the oral communication format specified in Outcome G.

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 students starting EE321 were only marginally aware of SPICE and MATLAB. Precursor classes should do a more thorough job of integrating these software packages into the EECS curriculum. Uniformly exposing transfer students to these software packages is an issue for discussion. EECS computer staff support MATLAB software very competently but drawing-based SPICE software is maintained less effectively. SPICE versions that require the use of "cir" files are considered archaic by EE321 students yet EECS does not adequately support the drawing-based versions of SPICE. Course evaluations showed notable comments on 1) Computer components contained in homework problems made the homework sets too long and 2) The EE321 instructor should start the Project earlier in the semester. [For spring 2006 semester, the instructor started the project on March 20, 2006.]

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.