I. Assessment Outcomes from the Course Syllabus

- (A) Ability to apply knowledge of mathematics, science and engineering.
- (C) Ability to design a system, component, or process to meet desired needs.
- (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. 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
6. Laplace transform in circuit analysis
7. Transfer functions
8. Frequency response, passive and active frequency selective circuits, Bode plots
9. Fourier series with circuit applications
10. Two-port networks
11. 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 (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 1-14, midterm exams 1-3, final exam, course project</td>
</tr>
<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>8</td>
<td>Homeworks 8 and 10, midterm exam 3</td>
</tr>
<tr>
<td>(E) Ability to identify, formulate, and solve engineering problems.</td>
<td>2-8</td>
<td>Homeworks 1,2 and 6, course project.</td>
</tr>
<tr>
<td>(G) Ability to communicate effectively in written and oral formats.</td>
<td>1-8</td>
<td>Course project</td>
</tr>
<tr>
<td>(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>2-8</td>
<td>Homeworks 1,2 and 6, course project.</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 2005 EE321, the average homework score (for homeworks 1-14) was 62%; average score on the three midterms was 66.5%; average final exam score was 66%, and average course project score was 72%. (Maximum possible score is 100% in all cases.) These assignments asked students to apply various mathematical techniques (e.g., state variables, differential equations, Laplace Transforms, Fourier Series, transfer functions and convolution) to analyze non-trivial passive and active circuits. These scores indicate that, on average, the students achieved outcome A.

(C) Ability to design a system, component, or process to meet desired needs.
For Fall 2005 EE321, the average homework 8 score was 80%; the average homework 10 score was 67%, and the average score on midterm 3 was 66%. (Maximum possible score is 100% in all cases.) These assignments asked the students to design passive and active frequency-selective circuits. These scores indicate that, on average, the students achieved outcome C.

(E) Ability to identify, formulate, and solve engineering problems.
For Fall 2005 EE321, the average homework 1 score was 64%; the average homework 2 score was 72%, the average homework 6 score was 63% and the average course project score was 72%. (Maximum possible score is 100% in all cases.) These assignments required students to use
MATLAB, along with state-variable, Laplace-transform, and convolution techniques, to solve for the outputs of non-trivial circuits and plot the results. MATLAB is an important modern software tool that is widely used in industry and academia. These scores indicate that, on average, the students achieved outcome E.

(G) Ability to communicate effectively in written and oral formats.
For Fall 2005 EE321, the average course project score was 72%. As the course project required a detailed typed project report with equations, tables, and figures, this score indicates that, on average, students demonstrated the ability to communicate effectively in writing. (The course project is further described in Section V below.)

(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.
For Fall 2005 EE321, the average homework 1 score was 64%; the average homework 2 score was 72%, the average homework 6 score was 63% and the average course project score was 72%. (Maximum possible score is 100% in all cases.) These assignments required students to use MATLAB, along with state-variable, Laplace-transform, and convolution techniques, to solve for the outputs of non-trivial circuits and plot the results. MATLAB is an important modern software tool that is widely used in industry and academia. These scores indicate that, on average, the students achieved outcome K.
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 2005 EE321, a student needed to achieve an average course score of at least 50%. The components and weighting of the course score were: homework (10%), course project (15%), three midterm exams (15% each), and final exam (30%). The average course score for Fall 2005 EE321 was 66.4%, indicating that most students achieved competency in the course material at a level above the minimum requirement for a C grade.

Course Project Summary
The course project is an important feature of EE321, and will now be briefly described. For the Fall 2005 EE321 course project, students were required to analyze a third-order passive bandpass filter circuit using four methods: (1) state-space method, with pre-written MATLAB functions used for determination of transfer function, impulse and step responses, and Bode plots; (2) Laplace transform method, plus approximation methods for sketching Bode plots; (3) classical differential equation method; and (4) discrete convolution, i.e., using the MATLAB “conv” command to determine the step response. Projects were performed independently by each student. Each student had a different value of one of the inductors in the circuit, so each student had a different solution. Part I of the project (the state-space part) was turned in on Sept. 30, graded, and returned to the students with solutions within a week, so that students would be encouraged to get at least part of their project done early, and so that they would have the correct solutions for the transfer function and impulse response of their circuit, for comparison with their solutions to the other parts of the project. The initial Part I grading counted for 10% of the total project grade. For the final due date of the project, a typed project report was required including introduction, summary of work done and results obtained for each part, and a conclusion comparing the four methods and summarizing what was learned.

Required Skills
Part I required the ability to derive the state space matrix equations and output matrix equations for a non-trivial circuit. In addition, Part I required the ability to use the relevant MATLAB commands to obtain the transfer function, and plots of the impulse, step, and frequency responses from the state-space model. Students were exposed to these MATLAB commands in homework assignments earlier in the semester Part II required the ability to solve for the transfer function, impulse response, and step response of a non-trivial circuit using the Laplace transform method, and the ability to use approximation techniques to hand-sketch Bode plots for the obtained transfer function. These techniques were taught during course lectures, with appropriate homework assignments. Part III required the ability to solve for the step response of a non-trivial circuit using the classical method of differential equation solution. These skills are taught in EE261, and reviewed in EE321. Part IV required the ability to write a simple MATLAB program to compute the impulse response (from Part II) at any given time t, and then to use the MATLAB convolution command to perform discrete convolution between the impulse response and a (discrete-time) unit step, thereby obtaining the step response.

Student Performance
The majority of students performed quite well on their projects. The average project score was 72%. 44 out of the 51 students who finished the class scored 50% or better on their project, and 19 students scored 80% or better. Given that the project required most of the key skills taught in EE321 (with the notable exception of Fourier Series), the solid performance of the class on their
course projects strongly supports the case that students completing Fall 2005 EE321 with a C or better achieved the intended outcomes of the course.

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’ MATLAB programming skills were weak. However, I believe the number of students with this problem was down from previous years I have taught the course, possibly due to the increased emphasis on programming in the first two years of the EE major curriculum. The proposed new required course on MATLAB for EE students should effectively address this problem. However, the instructor intends to include more MATLAB exercises in future offerings of EE321, to build students’ skills in MATLAB programming and application to circuits. The instructor also intends to move Fourier Series earlier in the course; having it as the last topic in the course was not appreciated by some students.

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.