Topic: Laplace Analysis I

Date: 22 March 2007 (Thursday)
Due: 27 March 07 (Tuesday following the lab)

Preliminary:
1. Bring your lab notebook, calculator and textbook.
2. Review the “General Comments Relating to Lab Work” regarding lab procedures.
3. Review the “Memorandum Reports for EE/CENG Projects” for guidelines on using your lab notebook.

Introduction:
The purpose of this experiment is to:
   a) Use the scope to estimate circuit time constant, natural frequency, and damping ratio.
   b) Use Laplace transforms to analyze the response of first and second order circuits using a voltage step forcing function.
   c) Reinforce the concepts from sections chapters 14 and 15 of the text.

Prior to Lab:
An introductory handout was reviewed during the 21 March class period. The handout contained an example of using Laplace transforms to analyze the response of a simple RL circuit when its forcing function was a voltage step.

In the Lab:
1. You will have the entire lab period from 2:00 to 4:00pm for your investigations.
2. We will have access to all twelve benches.
3. Work in groups of 2 or 3.
4. Record the following:

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<thead>
<tr>
<th>Date:</th>
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<tbody>
<tr>
<td>Equipment:</td>
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<td>Lab Bench #:</td>
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You may want to record the horizontal and vertical scale setting of your scope during this experiment.
Part a): Response of a Series RC Circuit Given a Voltage Step as Input

a) The objective of this section is to set up a series RC circuit and observe the response (output voltage) due to a voltage step input.

b) Use the following component values for this circuit:
   - R = 1k Ω
   - L = 0.1 uF

c) Use the Tektronix CFG250 2 MHz Function generator as $V_i$.
   - The signal generator should be set up to provide a 10 volt (peak) square wave as $V_i$.
   - Set the frequency of the square wave to 500 Hz.

d) Use the Tektronix TDS 2012 Dual Trace Scope to measure the magnitudes of $V_i$ and $V_o$.
   - Use channel 1 (yellow) to monitor the input.
   - Use channel 2 (blue) to monitor the output.
   - Use the trigger control if necessary to obtain a stable display. Trigger on channel 1.
   - Set both probes and both channel "Probe" menu items to "1X".

e) Set up your circuit as follows:

![Diagram of a series RC circuit]

f) Calculate the time constant of the circuit and record the value in your lab notebook.

g) Sketch the input and output waveforms in your lab notebook.

h) From the waveform and the calibration grids on the scope, estimate the time constant of the circuit.
Part b): Response of a Series RLC Circuit to a Voltage Step Forcing Function

a) Set up the following parallel resonant circuit:

b) Use the 500 Hz square wave as the forcing function.
c) You should see severe overshoot on the output waveform. You may have to adjust the horizontal (time) axis to get a good look at the overshoot part of the output waveform.
d) Calculate the natural frequency and damping ratio from the circuit component values.
e) Sketch the input and output waveforms in your lab notebook.
f) From the waveform and the calibration grids on the scope, estimate values of the natural frequency and damping ratio of the actual circuit.
**Post - Lab:**

Use graph paper to create the sketches requested below, and tape or paste the graphs into your lab notebook. Enter your commentary either directly into the lab notebook, or print it out and paste or tape your comments into the lab notebook.

a) For the RC series circuit with Vo across the capacitor:
   - Calculate the time constant of the circuit and record the value in your lab notebook.
   - Sketch the input and output waveforms in your lab notebook.
   - From the waveform and the calibration grids on the scope, estimate the time constant of the circuit.
   - Use Laplace transforms to calculate the response of the circuit to the square wave forcing function.
   - Compare your calculated and measured results. (Does the result from the Laplace analysis match what you saw on the scope? Does the calculated time constant match what you measured? etc....)

b) For the series resonant circuit with Vo across the capacitor:
   - Calculate the natural frequency and damping ratio from the circuit component values.
   - Sketch the input and output waveforms in your lab notebook.
   - From the waveform and the calibration grids on the scope, estimate values of the natural frequency and damping ratio of the actual circuit.
   - Use Laplace transforms to calculate the response of the circuit to the square wave forcing function.
   - Compare your calculated and measured results. (Does the result from the Laplace analysis match what you saw on the scope? Do the calculated natural frequency and damping ratio match what you measured? etc....)

c) Come see me if you would like to make arrangements to re-do some parts of the lab before next Tuesday.

d) Please do your best to prepare the above material in a neat and organized fashion.