**Topic:** Frequency Response of Second Order Circuits

**Date:** 15 March 2007 (Thursday)
**Due:** 20 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) Investigate the frequency response of 2nd order RLC series and parallel resonant circuits.
   b) Reinforce the concepts from sections 14.4, 14.5, and 14.6 of the text.

**Prior to Lab:**
Introductory handout was reviewed during the 14 March class period.

**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:

<table>
<thead>
<tr>
<th>Date:</th>
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</thead>
<tbody>
<tr>
<td>Equipment:</td>
<td>Lab Bench #:</td>
</tr>
</tbody>
</table>
Part a): Frequency Response of a Series RLC Circuit.

a) The objective of this section is to set up a series resonant RLC circuit and measure its frequency response.

b) For each of the circuits below, use the following component values:
   - $R = 100 \, \Omega$
   - $C = 1000 \, \text{pF}$ (use two 500 pF capacitors in parallel)
   - $L = 1 \, \text{mH}$

c) Use the Tektronix CFG250 2 MHz Function generator as $V_i$
   - The signal generator should be set up to provide a 3 volt (peak) sine wave as $V_i$.
   - Use channel 1 of the scope to monitor $V_i$. Make sure to maintain a constant 3 $V_{\text{peak}}$ input to the circuit. You will notice that the output of the signal generator will change as the total impedance of the circuit changes with frequency. In order to have a meaningful response plot, the $V_i$ must be held constant over the range of $V_o$ measurements.

d) Use the Tektronix TDS 2012 Dual Trace Scope to measure the magnitudes of $V_i$ and $V_o$.
   - The scope will be used to measure the peak value of both $V_i$ and $V_o$.
   - Set both probes and both channel "Probe" menu items to "1X".

e) Set up your circuit as follows:

![Series RLC Circuit Diagram]

f) Calculate the resonant frequency.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resonant frequency</td>
<td></td>
<td></td>
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</table>
g) Vary the frequency of $V_i$ from at least two decades below the resonant frequency to the maximum output frequency of the signal generator (2MHz). Record enough data points so that you can sketch the magnitude of the response later. You will probably want to record more points near the resonant frequency. We will not be recording phase angle measurements for this lab.

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<tbody>
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<td>$V_o$</td>
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<td></td>
</tr>
</tbody>
</table>

etc

h) Rearrange the circuit components as follows:

![Circuit Diagram]

i) Vary the frequency of $V_i$ from at least two decades below the resonant frequency to the maximum output frequency of the signal generator (2MHz). Record enough data points so that you can sketch the magnitude of the response later. You will probably want to record more points near the resonant frequency. We will not be recording phase angle measurements for this lab.

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etc
j) Rearrange the circuit components as follows:

k) Vary the frequency of $V_i$ from at least two decades below the resonant frequency to the maximum output frequency of the signal generator (2MHz). Record enough data points so that you can sketch the magnitude of the response later. You will probably want to record more points near the resonant frequency. We will not be recording phase angle measurements for this lab.

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etc

a) Set up the following parallel resonant circuit:

![Parallel Resonant Circuit Diagram]

b) Vary the frequency of $V_i$ from at least two decades below the resonant frequency to the maximum output frequency of the signal generator (2MHz). Record enough data points so that you can sketch the magnitude of the response later. You will probably want to record more points near the resonant frequency. We will not be recording phase angle measurements for this lab.

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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 series resonant circuit with \( V_o \) across the resistor:
   - Calculate the lower and upper half power points, bandwidth, and \( Q \).
   - Sketch the magnitude of the frequency response showing the half power points and bandwidth based on your measured data.
   - Make a Bode magnitude plot of \( V_o/V_i \).
   - Discuss any differences between your measured and calculated data.

b) For the series resonant circuit with \( V_o \) across the capacitor:
   - Calculate the lower and upper half power points, bandwidth, and \( Q \).
   - Sketch the magnitude of the frequency response showing the half power points and bandwidth based on your measured data.
   - Make a Bode magnitude plot of \( V_o/V_i \).
   - Discuss any differences between your measured and calculated data.

c) For the series resonant circuit with \( V_o \) across the inductor:
   - Calculate the lower and upper half power points, bandwidth, and \( Q \).
   - Sketch the magnitude of the frequency response showing the half power points and bandwidth based on your measured data.
   - Make a Bode magnitude plot of \( V_o/V_i \).
   - Discuss any differences between your measured and calculated data.

d) For the parallel resonant circuit with \( V_o \) across the resistor:
   - Calculate the lower and upper half power points, bandwidth, and \( Q \).
   - Sketch the magnitude of the frequency response showing the half power points and bandwidth based on your measured data.
   - Make a Bode magnitude plot of \( V_o/V_i \).
   - Discuss any differences between your measured and calculated data.

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

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