AC analysis, round 2

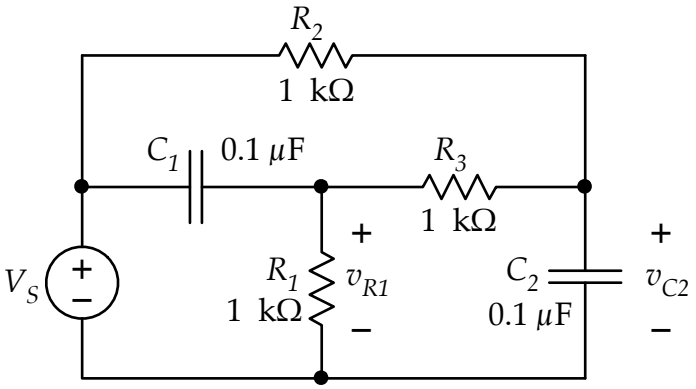
This week we continue our examination of *AC* circuits by trying a couple of multi-node (or multi-loop) circuits, and then we will look at one aspect of resonance in AC circuits.

1. A node-voltage problem

Set up the RC circuit shown in Fig. 1. Set the amplitude of the source at 5 V_{RMS} and the frequency at 1500 Hz, initially.

- Use the multimeter to measure the amplitudes of v_{R1} and v_{C2}.
- Use the oscilloscope to observe V_S and v_{R1} simultaneously, and measure the phase difference between the two sinusoids. Save a trace for your report.
- Then use the oscilloscope to observe V_S and v_{C2} simultaneously, and measure the phase difference between the two sinusoids. Save a trace for your report.
- Repeat all of the above measurements at frequencies of 300 Hz and 7500 Hz. (Saving traces is optional for the other frequencies.)
- Calculate the expected amplitude and phase for v_{R1} and v_{C2} at each of the three frequencies. This work can be done later, but be sure to include these calculations and results in your report.

Figure 1.



The table below may help you in collecting and organizing your data.

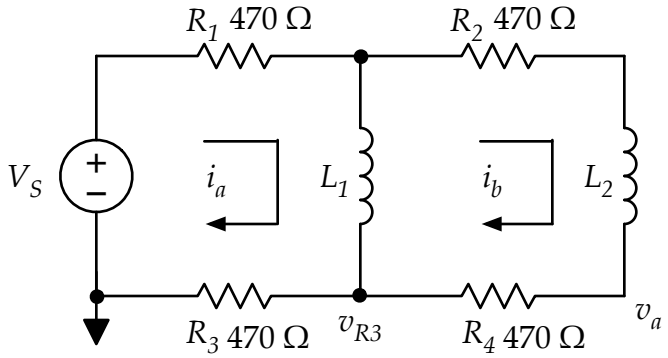
	$\lvert V_{R1} \rvert$	θ_{R1}	$\lvert V_{C2} \rvert$	θ_{C2}
300 Hz				
1500 Hz				
7500 Hz				

2. A mesh-current problem

Set up the RL circuit shown in Fig. 2. Set the amplitude of the source at 2 V_{RMS} and the frequency at 5000 Hz.

- Use the multimeter to measure the magnitudes of the two mesh currents, i_a and i_b. You can use the ammeter directly, or you can do it indirectly by measuring the voltages across R_3 and R_4 and using Ohm's law.
- Measure the phase of the current i_a. Do this by using the oscilloscope to observe the source voltage and the voltage across R_3 simultaneously, and measure the phase difference between the source and resistor sinusoids. Save a trace for your report. Of course, the resistor voltage is directly proportional to the current, so the phase difference is the same.
- Now measure the phase of the current i_a. To do this, you can use a third probe on the oscilloscope. Use the three probes to measure V_S, v_{R3}, and the node labeled v_a simultaneously. Use the math function to display v_{R4} by taking the difference between v_a and v_{R3}. (Since the display will be getting cluttered, you might want turn off the traces for v_{R3} and v_a, leaving only V_S and the difference trace.) With the source trace and the math trace, you can measure the phase difference.
- Repeat all of the above measurements at frequencies of 1000 Hz and 25 kHz. (It is not necessary to save traces at these other frequencies.)
- Calculate the expected amplitude and phase for i_a and i_b at each of the three frequencies. This work can be done later, but be sure to include these calculations and results in your report.

Figure 2.



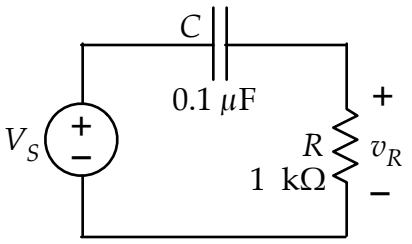
The table below may help you in collecting and organizing your data.

	$\lvert i_a \rvert$	θ_a	$\lvert i_b \rvert$	θ_b
1000 Hz				
5000Hz				
25 kHz				

3. A first look at resonance

Set up the RC circuit shown in Fig. 3. Set the amplitude of the source at 5 V_{RMS} and the frequency at 4 kHz.

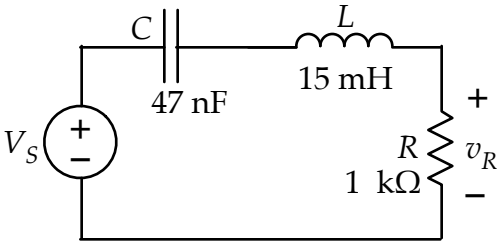
Figure 3.



- Use the multimeter to measure the magnitude of the resistor voltage. Calculate the AC power being dissipated in the resistor.
- Use the oscilloscope to measure the phase of the resistor voltage relative to the source. Save a trace for your report.
- Use the multimeter to measure the magnitude of the capacitor voltage. (If you want, you can also measure the capacitor voltage phase, but it is not necessary.)

Now add an inductor in series with the capacitor, as shown if Fig. 4. (Note: If you see distortion in the waveform after adding the inductor, reduce the amplitude of the source voltage. If you do reduce the voltage, be sure to keep track of the different source amplitudes in the two circuits.)

Figure 4.



- Use the multimeter to measure the magnitude of the resistor voltage. Calculate the AC power being dissipated in the resistor.
- Use the oscilloscope to measure the phase of the resistor voltage. Save a trace for your report.
- Use the multimeter to measure the magnitude of the capacitor and inductor voltages. (If you want, you can also measure the phases, but it is not necessary.)

With the inductor in place, you should see that the resistor voltage is closer to the source voltage than it was without the inductor. The inductor reactance is canceling out the capacitor reactance. At resonance, the two exactly cancel. It is unlikely that 4000 Hz is the exact resonance frequency for the *L* and *C* in your circuit. Try adjusting the frequency up and down slightly while observing the magnitude of the resistor voltage. When you find the peak value of resistor voltage, that will be the frequency of resonance. Record that frequency and then repeat the resistor measurements from above at the true resonance condition.

Reporting

Prepare a report discussing your calculations and measurements from each part of this lab. Be sure to include your calculations. The report is due in one week at your lab time.