

Experiment 11

Pre-Lab Activity

Read the above sections, the laboratory activity and the post-lab before coming to the Laboratory. Solve the following problems and submit your solution to your instructor.

Problems

1. Use Multisim to solve for the capacitor voltage for the circuit in Figure 7a. Assume $V_o = 4\text{V}$, $\omega = 10,000 \text{ rad/sec}$, $C = 0.1\mu\text{F}$, and $R = 1\text{k}\Omega$. Set the function generator's frequency to $f = \omega/2\pi = 1.59\text{kHz}$. Display the input voltage and the capacitor voltage on the virtual scope. Print (or save) the scope's display. Use the [scope cursors to find the time shift](#) (ΔX) between the two sinusoids. Determine the phase difference from the formula $\theta = \omega(-\Delta X)$.
2. Use the virtual [scope's XY](#) mode to plot the capacitor voltage versus the input voltage for the circuit Problem 1. Print (or save) the scope's display. Determine the phase difference employing the Lissajous method.
3. For the circuit in Problem 1, plot the capacitor voltage [use Equation (6)] against the input voltage. Calculate the theoretical value of the phase of the capacitor's voltage.
4. Derive the expression for the inductor voltage for the circuit in Figure 8a using Equations (8) and (9) and the fact that $i(t) = v_R(t)/R$.
5. Derive the expression for the capacitor voltage for the circuit in Figure 8a, using Equations (8) and (10).

Laboratory Activity

Required components:

One $1\text{k}\Omega$ resistor ($\pm 5\%$, $\frac{1}{2} \text{ W}$)

One 1mH ferrite-cored inductor ($\pm 10\%$, 70mA)

One $0.1\mu\text{F}$ multilayer ceramic capacitor ($\pm 10\%$)

1. Repeat Problem 1 experimentally.
2. Repeat problem 2 experimentally.

3. Change the source frequency in the neighborhood of 1.59kHz and document the changes in the shape of the Lissajous ellipse.
4. Build the circuit shown in Figure 8a. Use $R = 1\text{k}\Omega$, $L = 1\text{mH}$ and $C = 0.1\mu\text{F}$ components. Set the peak-to-peak voltage of the sinusoidal voltage source to 8V (verify using the scope). Measure the peak-to-peak value of the resistor's voltage signal (output signal) using the scope for the following values of ω : 100,000rad/s ($f \cong 15.9\text{kHz}$), 10,000 rad/s ($f \cong 1.59\text{kHz}$) and 1000,000 rad/s ($f \cong 159\text{kHz}$).
5. What is the experimental value of f for which the resistor voltage is maximized? What is the value of this maximum voltage?
6. Measure the *phase difference* between the output signal and the input signal for the following values of ω : 100,000 rad/s, 10,000 rad/s and 1000,000 rad/s. For what frequency range does the resistor voltage lead the input voltage?
7. Set the input sinusoid frequency to the value you obtained in Step 5. Save the scope's display.
8. Sort all components and give them back to your instructor.

Post-Lab Activity

Write a [technical report](#) that discusses your observations and includes analysis and justifications of all steps in this activity. Tabulate and/or plot experimental data whenever possible. More specifically, your report should address the following points:

- Compare the results of the Multisim simulation for Problem 1 and 2 and the theoretical results of Problem 3 to the experimental results of Step 1 and 2.
- What happens to the Lissajous ellipse in Step 3 as f changes?
- Compare the experimental result in Steps 4 through 7 to the corresponding theoretical results obtained employing Equation (8).