Experiment 5
Lab Activity

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. Consider the circuit in Figure 1 with R_1 = 1kΩ, R_2 = 470Ω, v_{s1} = 10 Volt and v_{s2} = 5 Volt. Use Multisim to solve for the voltages across and the current through R_1 and R_2.
2. Derive Equation (3).
3. Repeat Problem 1 (employing Multisim and superposition) to solve for the voltage across R_2 as the sum of the voltage across R_2 in the circuits of Figure 2(a) and (b), respectively. Also, find the current $i(t)$ by adding the currents of the circuits in Figures 2(a) and (b).
4. Compare the results from Problems 1 and 3 to those obtained using Equations (2) and (3).
5. Use the results of Problem 1 in Equation (4) to verify KVL for the circuit in Problem 1.
6. Consider the circuit in Figure 8 with R_1 = 1kΩ, R_2 = 1kΩ, R_3 = 470Ω, v_{s1} = 10 Volt and v_{s2} = 5 Volt. Employ Multisim to solve for the currents i_1, i_2, and i_3. Verify KCL as stated in Equation (5).

Laboratory Activity

Required components:

Two 1kΩ resistor (±5%, ½ W)

One 470Ω resistor (±5%, ½ W)

Note:

- All circuits in this experiment (and in all future experiments) should be constructed on the protoboard.
- When making current measurements, set the ammeter to display the reading in mA. Record your measurement with two significant digits to the right of the decimal point (employ rounding).
- When making voltage measurements, set the voltmeter to display the reading in Volts. Record your measurement with two significant digits to the right of the decimal point (employ rounding).
- When measuring resistance, set the Ohmmeter to *auto-range* and record the displayed reading accurate to two significant digits to the right of the decimal point.

1. Obtain the above resistors from your lab instructor and measure and record their actual resistance. Make sure you are able to distinguish between the two 1kΩ resistors.
2. Consider the circuit in Figure 1 with R_1 = 1kΩ, R_2 = 470Ω, v_{s1} = 10 Volt and v_{s2} = 5 Volt. Use the +30V and the +5V supplies on the DC power supply to set v_{s1} and v_{s2}, respectively. Use the voltmeter to measure the voltages across R_1 and R_2 and the voltages v_{s1} and v_{s2}. Refer to Figure 4 for proper voltmeter placement.
3. Use the ammeter to measure the current $i(t)$.
4. Build the circuits in Figure 2(a) and (b). For each circuit, measure and record the voltage across and the current through R_2.
5. Consider the circuit in Figure 8 with R_1 = 1kΩ, R_2 = 1kΩ, R_3 = 470Ω, v_{s1} = 10 Volt and v_{s2} = 5 Volt. Employ the ammeter to measure the currents i_1, i_2, and i_3. Refer to Figure 9 for proper placement of the

ammeter. Make sure to measure and record the actual resistance of the three resistors.

6. Consider the circuit in Figure 1 with R_1 = 1kΩ, R_2 = 470Ω, v_{s1} = 10 Volt and v_{s2} = 5sin(2000πt) Volt. Use the +30V supply of the DC power supply to generate v_{s1}. Use the function generator to generate v_{s2} (note: v_{s2} is a sine wave with 10Vpp and 1kHz frequency; the peak-to-peak value of v_{s2} should be confirmed using the scope, while the function generator is connected to the circuit). Use the scope to display and save the voltage waveform across R_2 (note the zero-voltage reference for the displayed signal). Recall that the scope must not be connected across a floating component. *Refer to Figure 7 for the proper connection of the scope to the circuit.*
7. **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:

Note:

- Use the actual (measured) resistor values in all theoretical calculations and in Multisim simulations.
- When you are asked to "compare" measured values to theoretical values, always compute the error in percent.

- Repeat the Multisim-based Pre-Lab Problems 1 and 2-6 employing the measured resistor and measured DC supply voltages.
- Compare your experimental results to those obtained employing Multisim.

- Verify the Superposition Law for voltage, $v_2 = v_2\big|_{v_{s2}=0} + v_2\big|_{v_{s1}=0}$, and for current, $i = i\big|_{v_{s2}=0} + i\big|_{v_{s1}=0}$, using the measurements obtained in Steps 2-4.
- Verify Kirchhoff's Voltage Law, $-v_{s1} + v_1 + v_2 + v_{s2} = 0$, using the measurements obtained in Step 2.
- Verify Kirchhoff's Current Law, $i_1 + i_2 + i_3 = 0$, using the measurements obtained in Step 5.
- Compare the measured signal from Step 6 to the theoretical answer obtained by using Equation (2).