Lab 6

AC Superposition

Objective

This exercise examines the analysis of multi-source AC circuits using the Superposition Theorem. In particular, sources with differing frequencies will be used to illustrate the contributions of each source to the combined result.

Theory Overview

The Superposition Theorem can be used to analyze multi-source AC linear bilateral networks. Each source is considered in turn, with the remaining sources replaced by their internal impedance, and appropriate series-parallel analysis techniques employed. The resulting signals are then summed to produce the combined output signal. To see this process more clearly, the exercise will utilize two sources operating at different frequencies. Note that as each source has a different frequency, the inductor and capacitor appear as different reactance to the two sources.

Equipment

1. AC Function Generators
2. Oscilloscope

Components

1. 0 .1 μF actual: ________
2. 10mH actual: ________
3. 1kΩ actual: ________

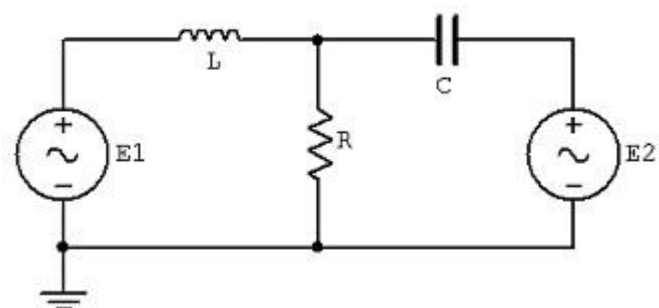

Figure 1

Procedure

To test the Superposition Theorem, sources E1 and E2 will be examined separately and then together.

Source One Only

1. Consider the circuit of Figure 1 with C=0.1 μF, L=10mH, R=1kΩ, using only source E1=2 $V_{p\text{-}p}$ at 1 kHz and with source E2 replaced by a 0-V voltage source represented as a short circuit. Using standard series parallel techniques; calculate the voltages across R. Record the results in Table 1.
2. Build the circuit of Figure 1 using C=0.1 μF, L=10mH, and R=1kΩ. Replace E2 with 0-V voltage source represented as a short circuit. Set E1 to 2V p-p at 1 kHz, unloaded. Place probe one across E1 and probe two across R. Measure the voltages across R, and record in Table 1.

Source Two Only

3. Consider the circuit of Figure 1 using only source E2=2 V p-p at 10 kHz and with source E1 replaced by 0-V voltage source represented as a short circuit. Using standard series-parallel techniques; calculate the voltages across R. Record the results in Table 2.

4. Replace the short circuit with source E2 and set it to $2V_{p-p}$ at 10 kHz, unloaded. Replace E1 with 0-V voltage source represented as a short circuit. Place probe one across E2 and probe two across R. Measure the voltages across R and record in Table 2.

Sources One and Two

5. Consider the circuit of Figure 1 using both sources, $E1=2V_{p-p}$ at 1 kHz and $E2=2V_{p-p}$ at 10 kHz. Add the calculated voltages across R from Tables 1 and 2. Record the results in Table 3.

6. Replace the short circuit with source E1 and set it to $2V_{p-p}$ at 1 kHz, unloaded. Both sources should now be active. Place probe one across R. Measure the voltages across R, and record in Table 3.

7. Repeat the experiment for 1uF capacitor, 1mH inductor and 1kΩ resistor.

Data Tables

Source One Only

	Theoretical	Experimental	% Deviation
V_R			

Table 1

Source Two Only

	Theoretical	Experimental	% Deviation
V_R			

Table 2

Sources One and Two

	Theoretical	Experimental	% Deviation
V_R			

Table 3

Questions

1. Why must the sources be replaced with a 50 Ω resistor instead of being shorted?
2. Do the expected maxima and minima from step 6 match what is measured in step 7?
3. Does one source tend to dominate the 1kΩ resistor voltage or do both sources contribute in nearly equal amounts? Will this always be the case?