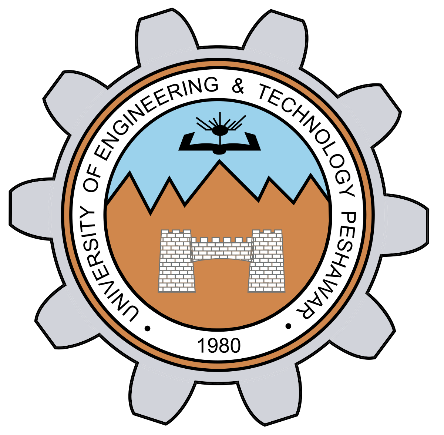
Lab 6

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AC Superposition

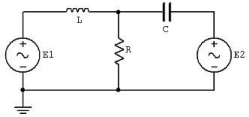
**Objective**

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-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 2Vp-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=2Vp-p at 1 kHz and E2=2Vp-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 2Vp-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 |
| VR | 2.0733-0.1355i | 1.89 | 0.02% |

**Table 1**

**Source Two Only**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Theoretical | Experimental | % Deviation |
| VR | 2.5627+0.547i | 2 | 0.122% |

**Table 2**

**Sources One and Two**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Theoretical | Experimental | % Deviation |
| VR | 2.215 | 2.278 | 1.0065% |

**Table 3**

**Data Tables (with changed values)**

**Source One Only**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Theoretical | Experimental | % Deviation |
| VR | 2.0020014 | 2 | 0.00354% |

**Table 1**

**Source Two Only**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Theoretical | Experimental | % Deviation |
| VR | 2.22209 | 2.2 | 0.1365% |

**Table 2**

**Sources One and Two**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Theoretical | Experimental | % Deviation |
| VR | 2.2231 | 2.2 | 1.435% |

**Table 3**

Questions

1. Why must the sources be replaced with a 50 Ω resistor instead of being shorted?

Because the function generator has internal built in 50 ohm resistance.

1. Do the expected maxima and minima from step 6 match what is measured in step 7?

They do not exactly match but are close to each other.

1. 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?

Source E1 tends to have a huge effect on resistor. This is caused by a huge value of capacitive impedance as compared to inductive impedance. If we change the values of capacitor and inductor such that their corresponding impedances are close to each other, this will not be the case.

MATLAB Code that I used to calculate values:

clc;

clear all;

R = 1000;

omega = 1000.0;

L = 10\*(10^-3);

C = 0.1 \* (10^-6);

Zc = 1/(C\*j\*omega);

Zl = j\*L\*omega;

RZc = (Zc\*R)/(Zc + R);

vol = (RZc/(Zl+RZc)) \* 2;

fprintf('Voltage when L = %f, C = %f, Frequency = %f, is %f\n', L, C, omega, abs(vol));

omega = 10000.0;

Zc = -j/(C\*omega);

Zl = j\*L\*omega;

RZl = (Zl\*R)/(Zl + R);

vol = (RZl/(Zc + RZl)) \* 2;

fprintf('Voltage when L = %f, C = %f, Frequency = %f, is %f\n', L, C, omega, abs(vol));

omega = 1000.0;

L = 1\*(10^-3);

C = 1 \* (10^-6);

Zc = 1/(C\*j\*omega);

Zl = j\*L\*omega;

RZc = (Zc\*R)/(Zc + R);

vol = (RZc/(Zl+RZc)) \* 2;

fprintf('Voltage when L = %f, C = %f, Frequency = %f, is %f\n', L, C, omega, abs(vol));

omega = 10000.0;

Zc = -j/(C\*omega);

Zl = j\*L\*omega;

RZl = (Zl\*R)/(Zl + R);

vol = (RZl/(Zc + RZl)) \* 2;

fprintf('Voltage when L = %f, C = %f, Frequency = %f, is %f\n', L, C, omega, abs(vol));