LAB # 6

CSE-203L Circuit & Systems-II Lab

Fall 2022

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Class Section: C

"On my honor, as student of University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work."

Student Signature: ______________

Submitted to:

Engr. Faiz Ullah

29th November, 2022

Department of Computer Systems Engineering

University of Engineering and Technology, Peshawar

TITLE:

AC Superposition

OBJECTIVES:

- To Analyze multi-source AC Circuits using AC Superposition Theorem.
- To study

APPARATUS:

- Oscilloscope
- AC Function Generator

COMPONENTS:

- 0.1 µF Capacitor
- 10 mH Inductor
- 1k Ω Resistor

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.

SUPERPOSITION PRINCIPLE:

The principle of superposition says that the output of a linear circuit due to several inputs working together is equal to the sum of the outputs working separately. The inputs to the circuit are the voltages of the independent voltage sources and the currents of the independent current sources.

CIRCUIT DIAGRAM:

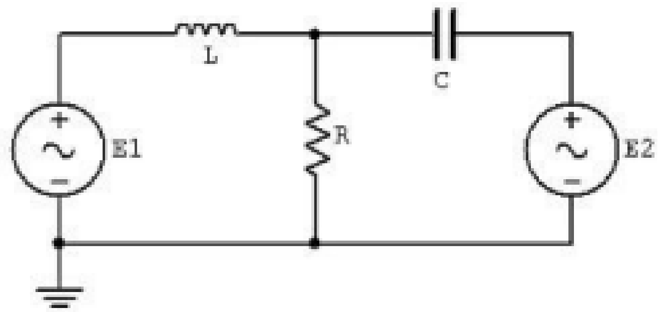


Figure 1

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

1. 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.

2. 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

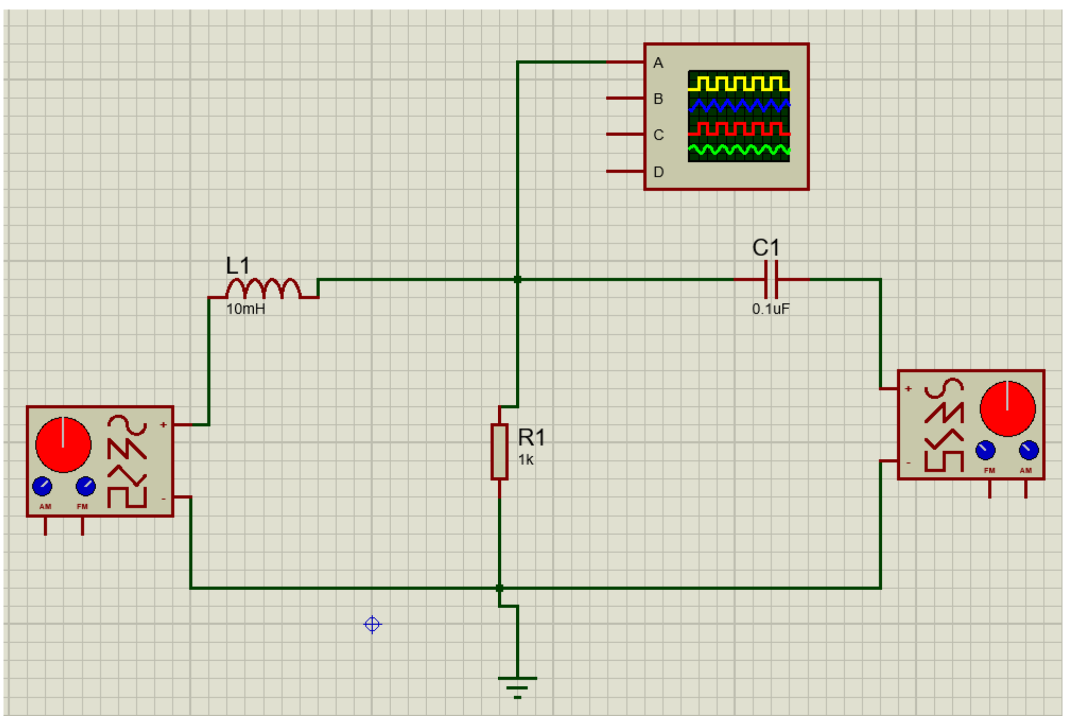
1. Consider the circuit of Figure 1 using both sources, E1=2Vp-p at 1 kHz and E2=2Vp-p at 10 kHz. Add the calculated voltages across R from Tables 1 and 2. Record the results in Table 3. 6. Replace the short circuit with source E1 and set it to 2Vp-p at 1 kHz, unloaded. Both sources should now be active. Place probe one across R. Measure the voltages across R, and record in Table 3.

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

OBSERVATIONS:

a) For V(p-p) = 2V, f1 = 1KHz, f2 = 10KHz, R = 1kΩ,L = 10mH, and C = 0.1µF

CIRCUIT DESIGN IN PROTEUS:



MATLAB CODE:

Editor - D:\MatlabWork\lab6.m

lab6.m

```
clc
clear all

a1 = -1591550j/(1000 - 1591.55j);
b1 = 62.83j + a1;
Vr1 = a1/b1 * (2+0j);

M1 = abs(Vr1);
theta1 = angle(Vr1);
deg1 = theta1 * (180/pi);

a2 = 628320j/(1000 + 628.32j);
b2 = -159.15j + a2;
Vr2 = a2/b2 * (2+0j);

M2 = abs(Vr2);
theta2 = angle(Vr2);
deg2 = theta2 * (180/pi);

t = 0:0.000001:0.003;
f1 = 1000;
f2 = 10000;
w1 = 2*pi*f1;
```

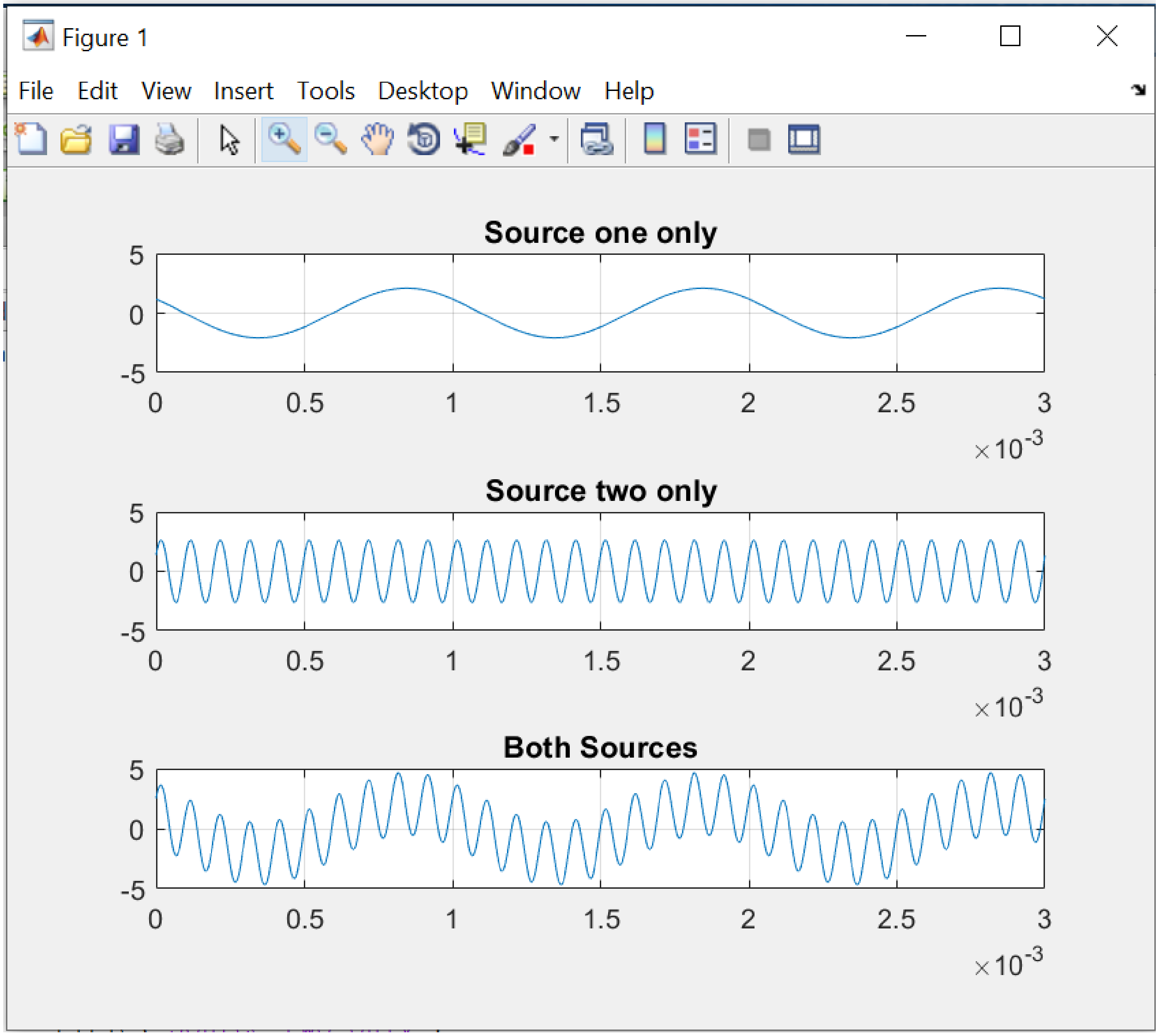
Editor - D:\MatlabWork\lab6.m

lab6.m

```
t = 0:0.000001:0.003;
f1 = 1000;
f2 = 10000;
w1 = 2*pi*f1;
```


```
w2 = 2*pi*f2;
Vr1 = M1*sin(w1*t + deg1);
Vr2 = M2*sin(w2*t - deg2);
Vr = Vr1 + Vr2;

subplot(311)
plot(t,Vr1)
grid on
title('Source one only')

subplot(312)
plot(t,Vr2)
grid on
title('Source two only')

subplot(313)
plot(t,Vr)
grid on
title('Both Sources')
```

CODE OUTPUT:



SOURCE 1 ONLY:

Table 1

	Theoretical	Experimental	%Deviation
V_R	2 V	2.1 V	%

SOURCE 2 ONLY:

Table 2

	Theoretical	Experimental	%Deviation
V_R	2.7 V	2.5 V	%

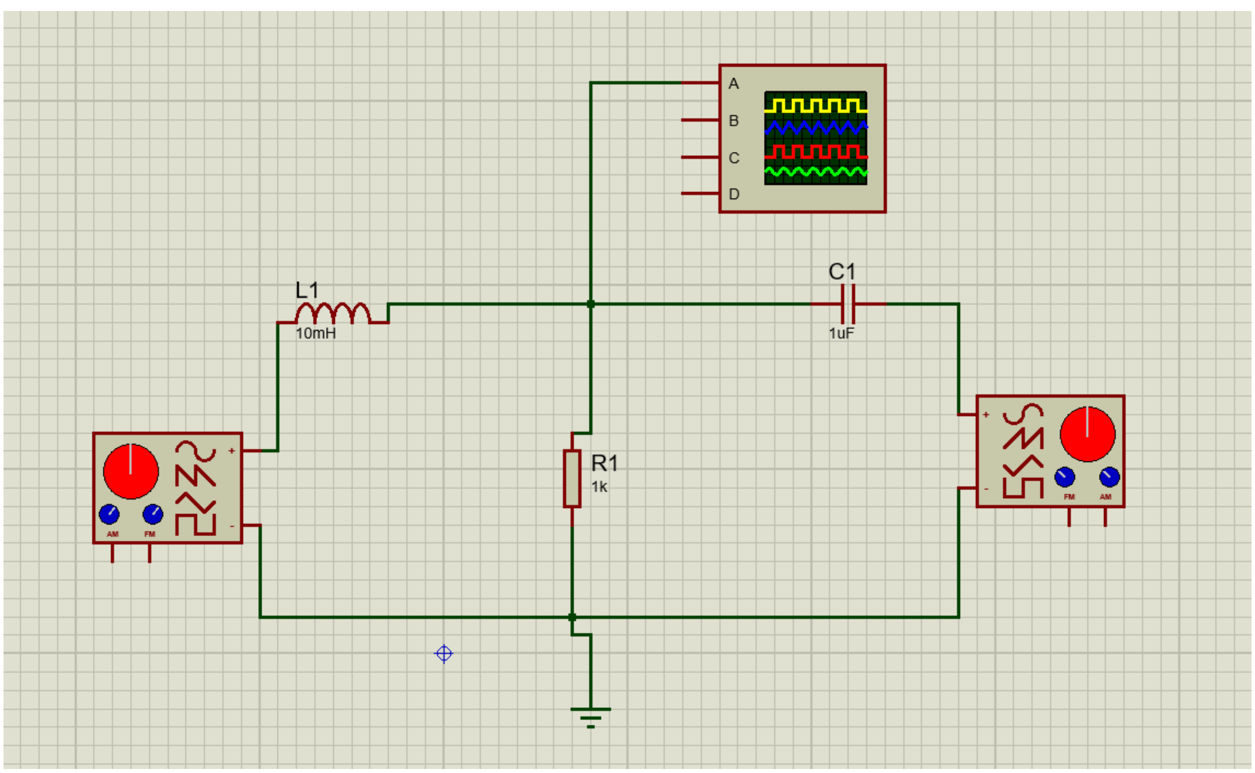
SOURCES 1 AND 2:

Table 3

	Theoretical	Experimental	%Deviation
V_R	4.6 V	4.56 V	%

b) For V(p-p) = 2V, f1 = 1KHz, f2 = 10KHz, R = 1kΩ,L = 10mH, and C = 1µF

CIRCUIT DESIGN IN PROTEUS:



MATLAB CODE:

Editor - D:\MatlabWork\lab6For1uF.m

lab6For1uF.m

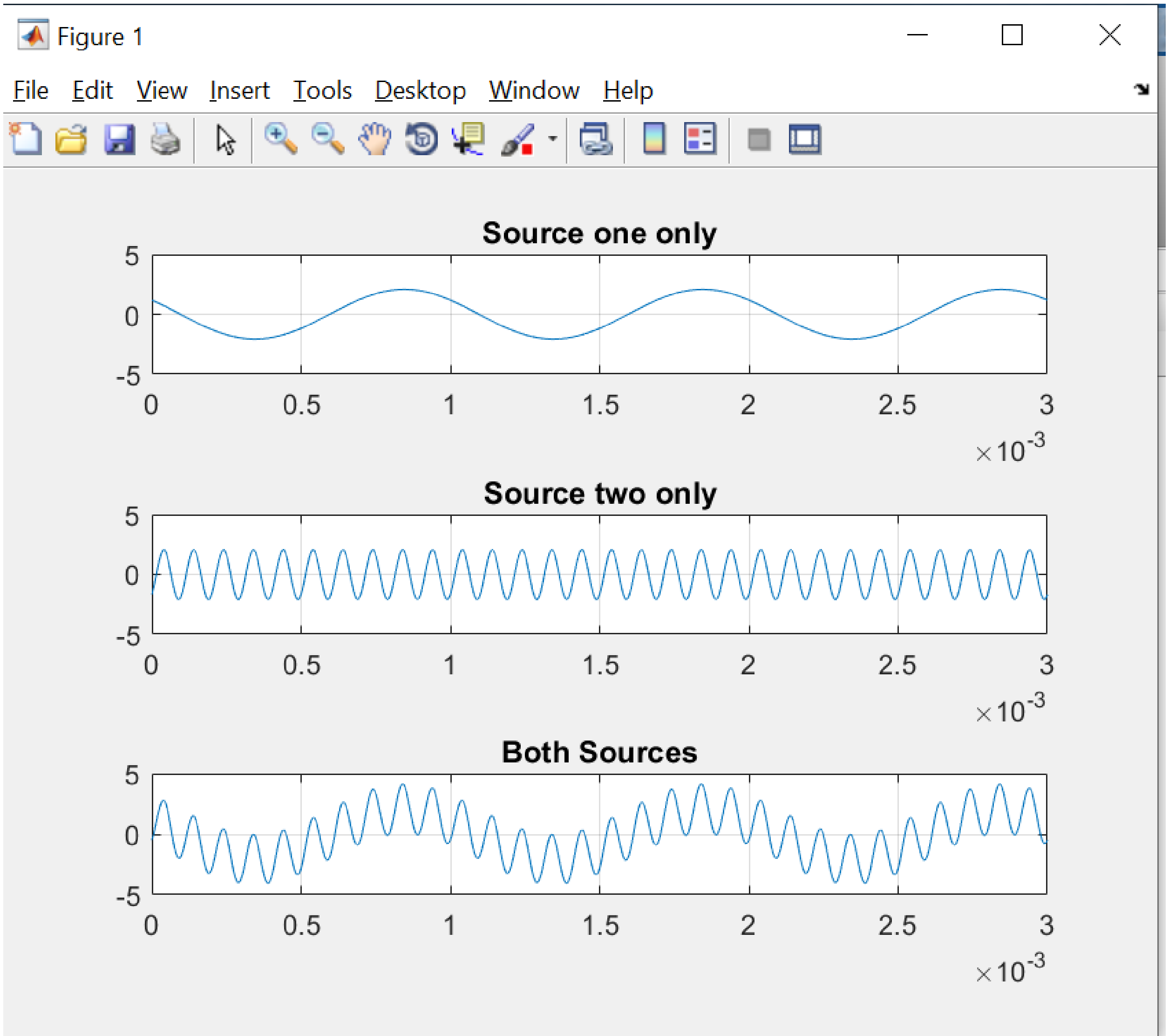
```
clc
clear all

R = 1000;
Zc1 =-1591.5i;
Ze1 = (R*Zc1)/(R + Zc1);
Zl1 = 2*pi*1000*0.01i;
Vr1 = (Ze1)/(Zl1 + Ze1) * (2+0j);

M1 = abs(Vr1);
theta1 = angle(Vr1);
deg1 = theta1 * (180/pi);

Zl2 = 2*pi*10000*0.01i;
Ze2 = (R*Zl2)/(R + Zl2);

Zc2 =-15.915i;

Vr2 = (Ze2)/(Zc2 + Ze2) * (2+0j);

M2 = abs(Vr2);
theta2 = angle(Vr2);
deg2 = theta2 * (180/pi);
```

Editor - D:\MatlabWork\lab6For1uF.m

lab6For1uF.m

```

t = 0:0.000001:0.003;
f1 = 1000;
f2 = 10000;
w1 = 2*pi*f1;
w2 = 2*pi*f2;
Vr1 = M1*sin(w1*t + deg1);
Vr2 = M2*sin(w2*t - deg2);
Vr = Vr1 + Vr2;

subplot(311)
plot(t,Vr1)
grid on
title('Source one only')

subplot(312)
plot(t,Vr2)
grid on
title('Source two only')

subplot(313)
plot(t,Vr)
grid on
title('Both Sources')
```

CODE OUTPUT:



SOURCE 1 ONLY:

Table 1

	Theoretical	Experimental	%Deviation
V_R	2 V	2.2 V	%

SOURCE 2 ONLY:

Table 2

	Theoretical	Experimental	%Deviation
V_R	3 V	3.1 V	%

SOURCES 1 AND 2:

Table 3

	Theoretical	Experimental	%Deviation
V_R	5 V	5.1 V	%

ANSWERS OF QUESTIONS:

Q1: Why must the sources be replaced with a 50 Ω resistor instead of being shorted?

ANS: current flows in the least resistance path, for current to not flow in the path of second source when it is removed we short its path with appropriate resistance value which in this case, which in this case is 50 Ω.

Q2: Do the expected maxima and minima from step 6 match what is measured in step 7?

ANS: No. They don't.

Q3: 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?

ANS: Clearly from the table 1 and 2, the ac source with greater frequency (10k Hz) dominate over less frequency (1k Hz) source in spite of having same peak to peak voltage (2V) also the source with more peak-to-peak voltage will contribute more to the 1k resistor. They will equally contribute when both sources have same peak to peak voltage and frequency.

CONCLUSION:

We can conclude the following results from this experiment:

- Superposition theorem can also be applied to AC Circuits
- In case of AC, as a result of superposition, the resulting amplitude of AC Sine wave is the sum of the individual waves due to single source.