American International University-Bangladesh (AIUB)

AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)
Faculty of Engineering
Department of EEE and CoE
Undergraduate Program

Course: Introduction To Electric Circuit **Exp No: 09** Fall :2021

Title: Analysis of RLC parallel circuit and verification of KCL in AC circuits.

Submitted by

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Submitted To

FACULTY NAME
Faculty of Engineering
Department of EEE
American International University-Bangladesh

Title: Analysis of RLC parallel circuit and verification of KCL in AC circuits.

Introduction: The objectives of this experiment are-
- To determine phase relationship between IL and IC in a RLC parallel circuit.
- Draw the complete vector diagram for a RLC parallel circuit.
- Verification of KCL in AC circuits.

Theory and Methodology: In dc circuits, conductance (G) was defined as being equal to 1/R. The total conductance of a parallel circuit was then found by adding the conductance of each branch. The total resistance RT is simply1/GT. In ac circuits, we define admittance (Y) as being equal to 1/Z. The unit of measure for admittance as defined by the SI system is Siemens, which has the symbol S. Admittance is a measure of how well an Ac circuit will admit, or allow, current to flow in the circuit. The larger its value, therefore, the heavier the current flow for the same applied potential. The total admittance of a circuit can also be found by finding the sum of the parallel admittances. The total impedance ZT of the circuit is then 1/YT; that is, for the network of Fig.

$$YT = Y1 + Y2 + Y3 + \dots \dots \dots \dots + YN$$

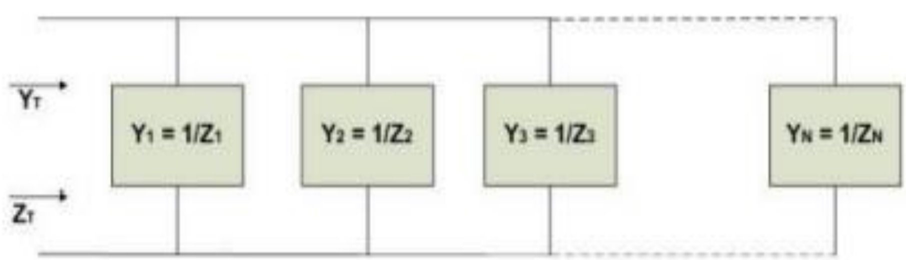


Fig. 1

Or, Since Z = 1/Y,

$$1/ZT=1/Z1+1/Z2+1/Z3+ \ldots\ldots\ldots +1/ZN$$

For two impedances in parallel,

$$1/ZT=1/Z1+1/Z2$$

$$ZT = Z1Z2/(Z1 + Z2)$$

For three parallel impedances,

$ZT = Z1Z2Z3/(Z1Z2 + Z2Z3 + Z1Z3)$ As pointed out in the introduction to this section, conductance is the reciprocal of resistance, and

$YR = 1/ZR = 1/R\angle 0° = G\angle 0°$

The reciprocal of reactance (1/X) is called susceptance and is a measure of how susceptible an element is to the passage of current through it. Susceptance is also measured in Siemens and is represented by the capital letter B. For the inductor,

$YL = 1/ZL = 1/XL\angle 90° = 1/XL(\angle -90°)$

Defining $BL = 1/XL$ (siemens, S)

$YL = BL \angle -90°$

Note that for inductance, an increase in frequency or inductance will result in a decrease in susceptance or, correspondingly, in admittance.

For the capacitor,

$$YC = 1/ZC = 1/(XC\angle - 90\ °) = 1/XC\ \angle 90°$$

Defining $BC = 1/XC$ (semens, S) $YC = BC\ \angle 90°$

For the capacitor, therefore, an increase in frequency or capacitance will result in an increase in its susceptibility. For any configuration (series, parallel, seriesparallel, etc.), the angle associated with the total admittance is the angle by which the source current leads the applied voltage. For inductive networks, θT is negative, whereas for capacitive networks, θT is positive.

Apparatus:

- Oscilloscope
- Function generator
- Resistor: 100 Ω (3)
- Inductor: 6.3 mH
- Capacitor: 1uF
- Connecting wire.
- Bread board

Given Circuit:

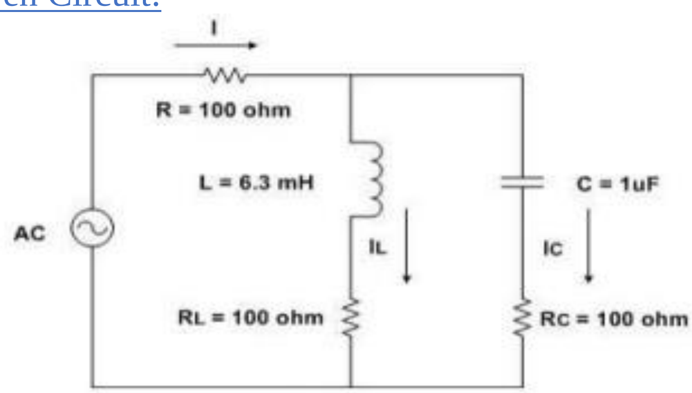
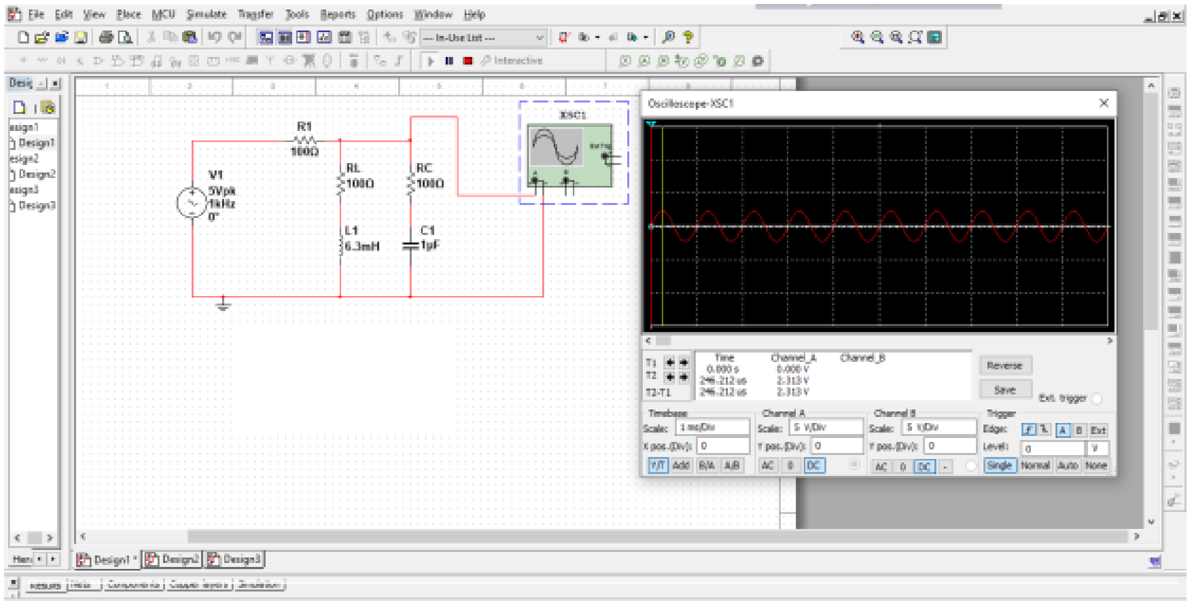
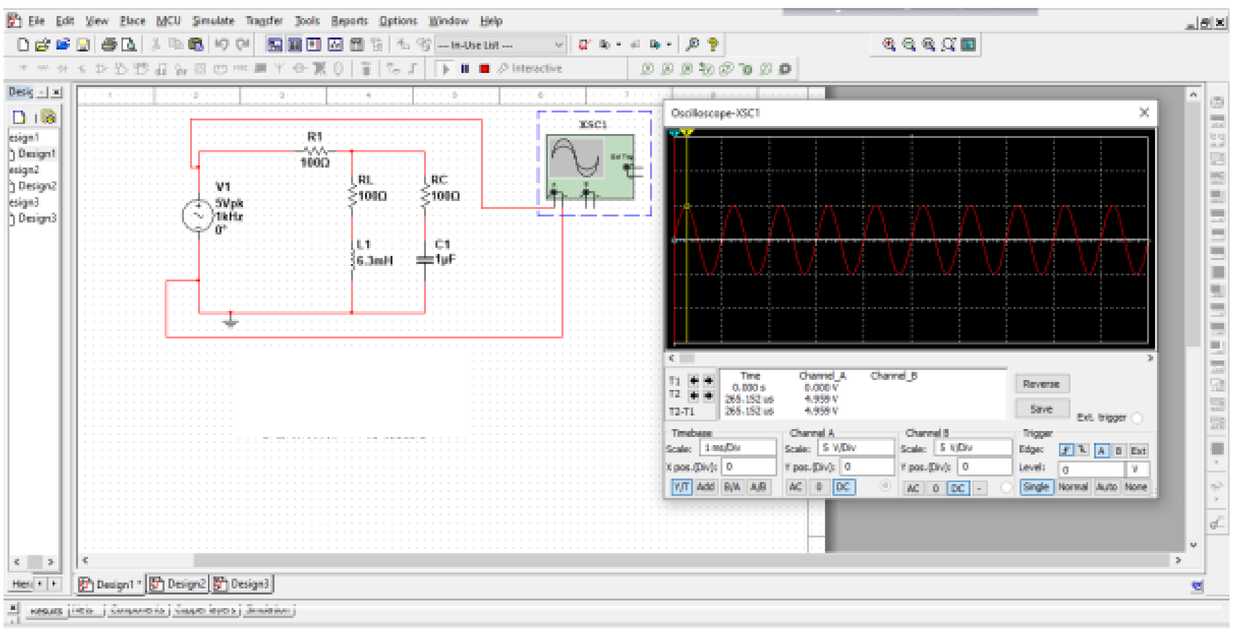


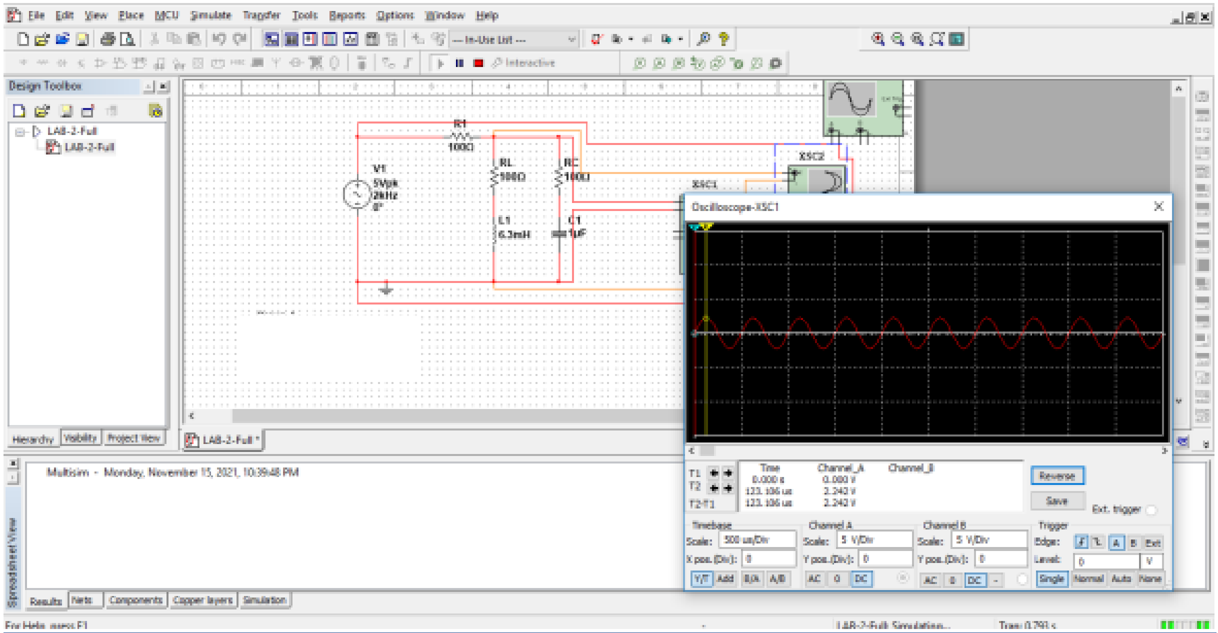
Fig. 2

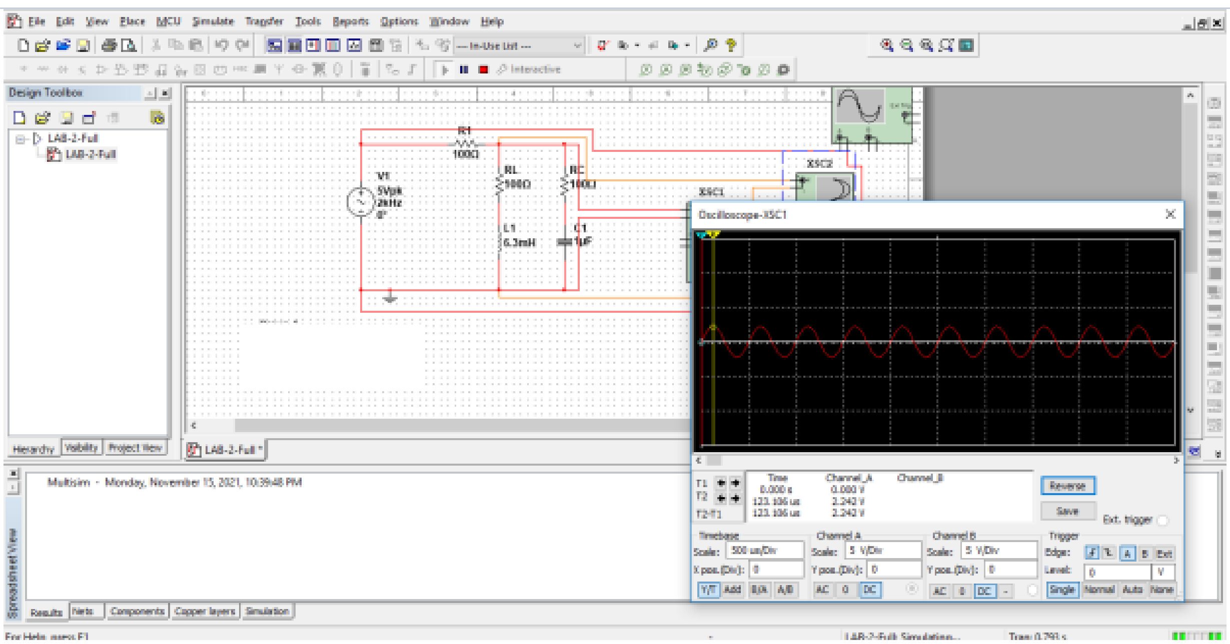
Simulation & Result:

For Fig-01:






Oscilloscope-XSC1
R1
100Ω
V1
5Vpk
2kHz
0°
RL
100Ω
RC
100Ω
L1
6.3mH
C1
1uF
XSC2
XSC1
LAB-2-Full
Multisim - Monday, November 15, 2021, 10:39:48 PM
Time
Channel_A
Channel_B
0.000 s
0.000 V
123.106 us
2.242 V
123.106 us
2.242 V
Reverse
Save
Ext. trigger
Timebase
Scale: 500 us/Div
X pos.(Div): 0
Channel A
Scale: 5 V/Div
Y pos.(Div): 0
Channel B
Scale: 5 V/Div
Y pos.(Div): 0
Trigger
Edge:
Level: 0 V
Single
Normal
Auto
None
LAB-2-Full Simulating...
Tran: 0.793 s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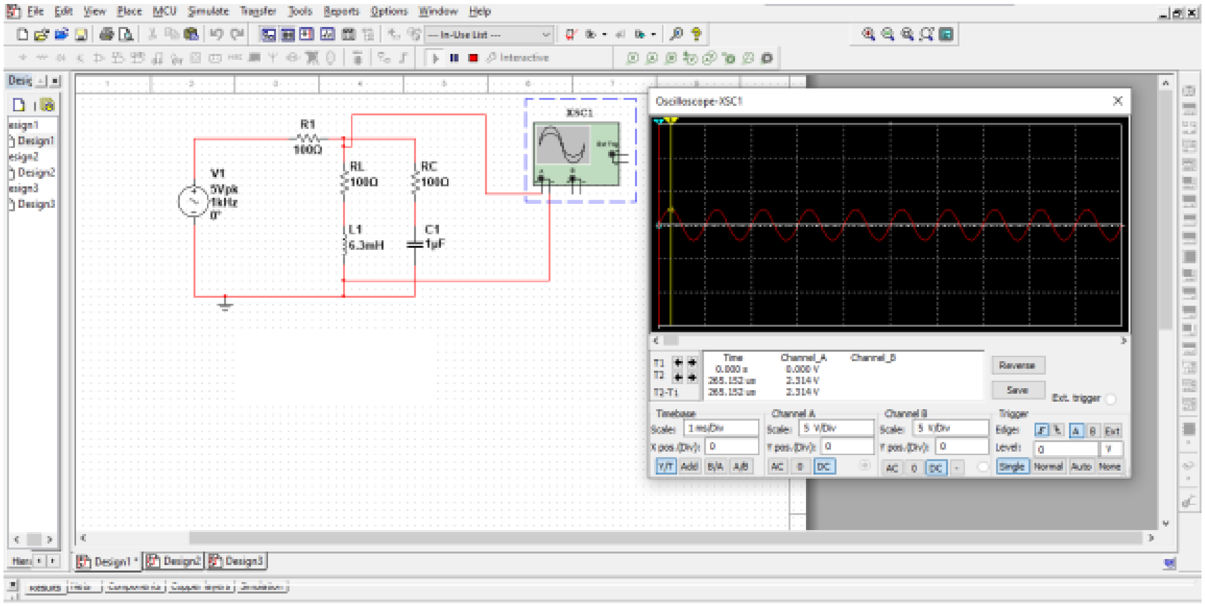

Table 1:

f (KHz)	E	V_{RL} (volts)	$I_L=V_{RL}/R_L$ A	θ L	V_{RC} (Volts)	$I_c=V_{Rc}/R_c$ A	θ c	I_L+I_C A	V_R (volts)	$I=V_R/R$ A
1Khz	5	2.313	0.02313	21.6	2.313	0.02313	-57.85	0.05	4.959	0.05
2Khz	5	2.229	0.223	38.16	2.242	0.0224	-38.50	0.0447	4.447	0.0447
4Khz	5	2.297	0.02297	57.72	2.297	0.02297	-21.69	0.04597	4.594	0.04597

Calculation (Theoretically):

1. For 1 kHz

$E = 5V$

$V_{RL} = 2.313V$

$I_L = \frac{V_{RL}}{R_L} = \frac{2.313}{100}$

$= 0.02313A$

$X_L = 2\pi f L$

$X_L = 2 \times 3.1416 \times 1000 \times 6.3 \times 10^{-3}$

$= 39.58$

Now,

$\theta_L = \tan^{-1}\left(\frac{X_L}{R}\right)$

$= \tan^{-1}\left(\frac{39.58}{100}\right)$

$= 21.6$

$X_C = \frac{1}{2\pi f C} = \frac{1}{2 \times 3.1416 \times 1000 \times 1 \times 10^{-6}}$

$= 159.15$

$\theta_C = \tan^{-1}\left(\frac{-X_C}{R}\right)$

$= \tan^{-1}\left(\frac{-159.15}{100}\right) = -57.85$

$V_{Rc} = 2.313$

$I_c = \frac{V_{Rc}}{R_c} = \frac{2.313}{100}$

$= 0.02313$

$I_L + I_c = 0.02313 + 0.02313$

$= 0.05$

$V_R = 4.959V$

Now

$I = \frac{V_R}{R} = \frac{4.959}{100}$

$= 0.04959$

$= 0.05$

For 2kHz:

$E = 5V$

$V_{RL} = 2.229$

$I_L = \frac{V_{RL}}{R_L} = \frac{2.229}{100}$

$= 0.0223$

We know,

$X_L = 2\pi f L$

$= 2 \times 3.1416 \times 2000 \times 6.3 \times 10^{-3}$

$= 79.16$

Now,

$\theta_L = \tan^{-1}\left(\frac{X_L}{R}\right)$

$= \tan^{-1}\left(\frac{79.16}{100}\right)$

$= 38.36$

$X_C = \frac{1}{2\pi f c} = \frac{1}{2 \times 3.1416 \times 2000 \times 1 \times 10^{-6}}$

$= 79.57$

$\theta_C = \tan^{-1}\left(-\frac{X_C}{R}\right)$

$= \tan^{-1}\left(-\frac{79.57}{100}\right)$

$= -38.50$

$V_{Rc} = 2.242$

$I_c = \frac{V_{Rc}}{R_c} = \frac{2.242}{100} = 0.02242$

Now

$I_L + I_C = 0.0223 + 0.0224$

$= 0.0447 \text{ A}$

$V_R = 4.447$

$I = \frac{V_R}{R} = \frac{4.447}{100}$

$= 0.0447 \text{ A}$

For 4kHz:

$E = 5V$

$V_{RL} = 2.297$

$I_L = \frac{V_{RL}}{R_L} = \frac{2.297}{100}$

$= 0.02297 \text{ A}$

$X_L = 2\pi f L$

$= 2 \times 3.1416 \times 4000 \times 6.3 \times 10^{-3}$

$= 152.33$

Now.

$\theta_L = \tan^{-1}\left(\frac{152.33}{100}\right)$

$= 57.72$

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$$X_C = \frac{1}{2\pi f_C} = \frac{1}{2\times 3.1416 \times 4000 \times 1\times 10^{-6}}$$

$$= 39.78$$

$$\theta_C = \tan^{-1}\left(\frac{-X_C}{R}\right)$$

$$= \tan^{-1}\left(-\frac{39.78}{100}\right)$$

$$= -21.69$$

$$V_{RC} = 2.297$$

$$I_C = \frac{V_{RC}}{R_C} = \frac{2.297}{100}$$

$$= 0.02297$$

Now,

$$I_L + I_C = 0.12297 + 0.02297$$

$$= 0.84594\ A$$

$$V_R = 4.594$$

$$I = \frac{V_R}{R} = \frac{4.594}{100}$$

$$= 0.04594$$

Discussion:

1. In this experiment, firstly we checked the oscilloscope & if the probs were perfect so that we could start.
2. Then we connected the probs to the channels & gave frequency to the function generator to get respective sinusoidal wave.
3. After doing all the steps, we got a value which was very close to our expected value.

Conclusions: Analyzing of RLC parallel circuit & verification of KCL in AC circuits are done in this experiment. So the experiment is successful.

Reference:

1. R.M. Kerchner and G.F. Corcoran, “Alternating Current Circuits”, John Wiley & Sons, Third Ed., New York, 1956