AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

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Assignment Title:	Construct an R-L-C circuit with a series parallel combination and apply KCL and KVL in AC and analyze the behavior of the circuit through data obtained during Laboratory work.
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Abstract:-

The experiment was conducted to construct an RLC-circuit with a series-parallel combination and apply 'KCL' and 'KVL' in AC and analyze the behaviour of the circuit through data obtained during laboratory work. The objectives of the experiment are to build and RLC-series parallel circuit and verify KVL and KCL in the AC circuit and also justify the AC analysis technique.

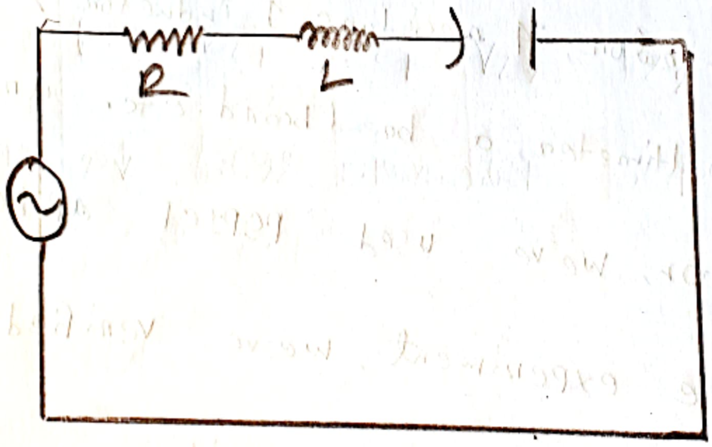
In this experiment, some basic tools like an oscilloscope, function generator, 4 resistors, 1 inductor, 2 capacitors, connecting wires, a multimeter, a bread board, etc. are used.

For simulation, we've used PSPICE application. By the end of the experiment, we've verified the 'KVL' and 'KCL' of the AC circuit.

Theory:-

When resistors, inductors, and capacitors are connected to an AC supply, the voltage is "in-phase" with the current in a resistor, and voltage forms of pure capacitors lag behind the current. The voltage -

→ forms of a pure capacitor lag by 90 degrees and a pure inductor leads by 90 degrees with the current. The phase difference depends upon the reactive value of the components used. Instead of analyzing every passive part on an individual basis, we tend to combine the elements all together to form an RLC circuit of series combination or parallel combination.



RLC CIRCUIT

Relevant Equation:-

Capacitive reactance; $X_C = \frac{1}{2\pi fC}$

Inductive reactance, $X_L = 2\pi fL$

Net reactance, $X = X_L - X_C$

Total impedence, $Z = \sqrt{R^2 + X^2}$

Current, $I = \frac{V}{Z}$

Resistive Voltage, $V_R = I \times R$

Reactive voltage drops $= V_L - V_C$, where $V_L = I \times X_L$ and $V_C = I \times X_C$

Total voltage drop $= \sqrt{V_R^2 + (V_L - V_C)^2}$

Total impedence for series circuit $= Z_T = Z_1 + Z_2 + Z_3$

Total impedence for Parallel Circuit $= \frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}$

In fig, 1.1, we can Proof KVL as, $V = V_1 + V_2$

In fig, 1.2, we can Proof KCL as, $I = i_1 + i_2 + i_3$

In Parallel RLC circuit, the total impedence is denoted by Z_T, is parallel circuit the Impedence is reciprocal of total impedence $\frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}$. In Parallel RLC circuit the voltage remains same and current is devided. Using kirchoffs current law we can proof the current entering a junction is equal to the sum of current leaving a junction.

P.T.O

~~Ans~~,

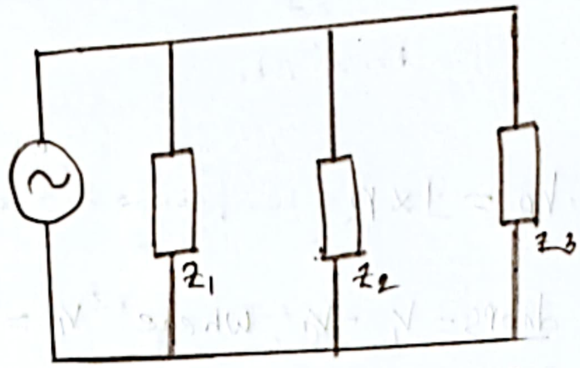


fig 2.1:- Parallel circuit.

Total Impedence:- $\frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}$ ......(eq)

In Series RLC circuit, the total is denoted by Z_T in-series circuit. The total impedence is equal to the sum of all impedence in the circuit. In series RLC circuit the current remains the same and voltage is divided using kirchoffs voltage law, we can proof that the sum of - of voltage rise is equal to the sum of voltage drop.

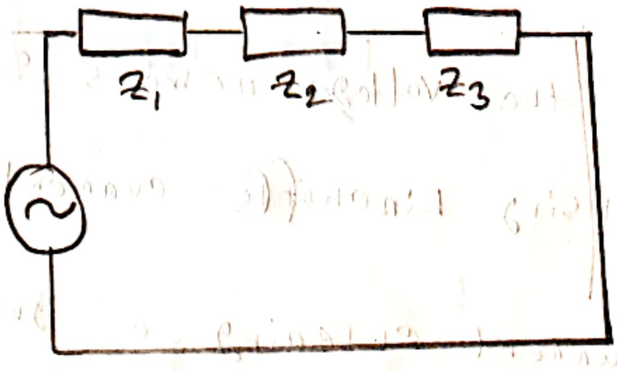


fig 2.2:- Series Circuit

Total impedence :- $Z_T = Z_1 + Z_2 + Z_3$ ......(eq)

Apparatus:-

1. Oscilloscope.
2. AC supply.
3. Wires.
4. Breadboad.
5. Multimeter.
6. 4 resistors.
7. 2 capacitors.
8. 1 inductor.

Circuit Diagram:-

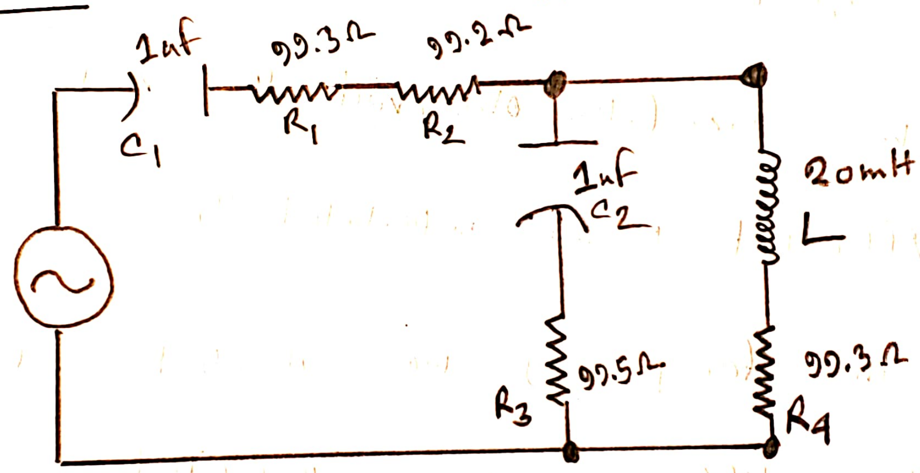


fig 3:- RLC circuit of Series-Parallel combination.

Procedure:-

① Firsly, the components were placed on the breadboard according as shown in the circuit diagram above.

② Now, the components were connected with each - other, the capacitor C_1 and resistors R_1 and R_2 -

are in series with C_2, L, R_3, R_4. where, other were connected in parallel,

3. The AC source supply was connected to the circuit in order to complete the circuit. The experiment was conducted in only one frequency which is 1kHz.

4. we've measured the resistance of each resistor using a multimeter.

5. we carefully observed the Vp-p and calculated Vrms. Afterthat we've calculated Irms as $I_{rms} = \frac{V_{rms}}{R}$.

6. The frequency was changed and Vp-p, time period, Phase-difference were recorded.

7. 'KVL' and 'KCL' was verified and proofed with the experimental data and simulalated data.

8. Experimental percentage error was calculated by comparing experimental data and simulated data.

Theoritical Data Table 1:-

f	E	V_{Z_1}	I_{Z_1}	V_{Z_2}	I_{Z_2}	V_{Z_3}	I_{Z_3}
1 kHz	2 V	1.3789	4.84×10^{-3}	0.68	0.3879	0.68	4.4578

Experimental Data Table 2:-

f	E	V_{Z_1}	I_{Z_1}	V_{Z_2}	I_{Z_2}	V_{Z_3}	I_{Z_3}
1 kHz	2 V	0.692	3.490×10^{-3}	0.089	8.501×10^{-4}	0.917	4.20×10^{-3}

Theoretical Calculation:-

$$X_{C_2} = X_{C_1} = \frac{1}{2\pi f C} = \frac{1}{2 \times 3.1416 \times 1 \times 10^{-6} \times 1000}$$

$$= 159.1549\ \Omega$$

$$X_L = 2\pi f L = 2 \times \pi \times 1000 \times 20 \times 10^{-3}$$

$$= 125.6637$$

$$Z_1 = (99.3 + 99.2) - j\,159.159$$

$$= 198.5 - j\,159.152$$

$$= 254.42 \angle -38.72^{\circ}$$

$$Z_2 = 99.5 - j\,159.154$$

$$Z_3 = 99.3 + j\,125.664$$

$$Z_{23} = \frac{Z_2 Z_3}{Z_2 + Z_3}$$

$$= 148.875 + j\,8.4778$$

$$Z_T = Z_1 + Z_{23}$$

$$= 347.3750 - j\,150.6761$$

$$I = \frac{2V}{Z_T} = 4.84571 \times 10^{-3} + j\, 2.1018832 \times 10^{-3}$$
$$= 5.281 \times 10^{-3} \angle 23.4488^{\circ}$$

$$I_{Z_2} = \frac{Z_{23}}{Z_2} \times I$$

$$= 0.38\cancel{7}93 \times 10^{-3} + j\, 4.17850 \times 10^{-3}$$
$$= 4.19 \times 10^{-3} \angle 84.69^{\circ}$$

$$I_{Z_3} = \frac{Z_{23}}{Z_3} \times I$$

$$= 4.457829 \times 10^{-3} - 2.0764 \times 10^{-3}$$
$$= 4.91 \angle -24.975$$

Here,

$$V_{Z_1} = I_{Z_1} + Z_1$$
$$= (198.5 - 159.154j) \times (4.845 \times 10^{-3} + 2.10 \times 10^{-3} j)$$

$$= 1.3789 - 1.1056j$$

$$V_{Z_2} = I_{Z_2} \times Z_2$$
$$= (0.38 \times 10^{-3} + 4.17 \times 10^{-3}) \times (99.5 - j\, 159.159)$$

$$= 0.668 + 1.1056j$$

$$\therefore I_{Z_2} + I_{Z_3} = (0.38793 \times 10^{-3} + j\, 4.17850 \times 10^{-3}) +$$
$$= (4.457824 \times 10^{-3} - j\, 2.0764 \times 10^{-3})$$
$$= 4.8457 \times 10^{-3} + j\, 2.1018832 \times 10^{-3}$$

$$V_{Z_1} + V_{Z_2} = (1.3789 - 1.1056j) + (0.668 + 1.1056j)$$
$$= 2.0469 \approx 2V$$

$\times 10^{-3}$

Experimental Calculation:-

$V_{Z1} = 0.980 \times 0.707$
$= 0.692$

$I_{Z_1} = \frac{0.692}{198.5}$
$= 3.490 \times 10^{-3}$

$V_{Z_2} = 0.120 \times 0.707$
$= 0.084$

$I_{Z_2} = \frac{0.084}{99.5}$
$= 8.501 \times 10^{-4}$

$V_{Z_3} = 0.590 \times 0.707$
$= 0.417$

$I_{Z_3} = \frac{0.417}{99.3}$
$= 4.20 \times 10^{-3}$

$I_{Z_2} + I_{Z_3} = (8.501 \times 10^{-4} + 4.20 \times 10^{-3})$
$= 5.05 \times 10^{-3}$

$V_{Z_1} + V_{Z_2} + V_{Z_3} = (0.692 + 0.084 + 0.417)$
$= 1.193$

Percentage of error:-

~~For I_2~~

For KCL,

$$= \frac{4.84\times10^{-3} - 3.490\times10^{-3}}{3.490\times10^{-3}} \times 100$$

$$= 38.68\ \%$$

~~For I_2~~

For KVL,

$$\cancel{= \frac{0.387\times10^{-3} - 8.501\times10^{-4}}{8.501\times10^{-4}}} \times 100$$

$$\cancel{= 54.47}$$

$$= \frac{2 - 1.93}{1.93} \times 100$$

$$= 3.6\ \%$$

Discussion:-

In this experiment, we've built a RLC-Series-Parallel circuit. Also, we've calculated and measured-Vrms and I for various components. Thus, we-tried to verify the KCL and KVL. There may-sight change or error in measured value due to internal resistance and the prediction of-wave amplitude through wave. We tried to take the value carefully to less the error.

Conclusion:-

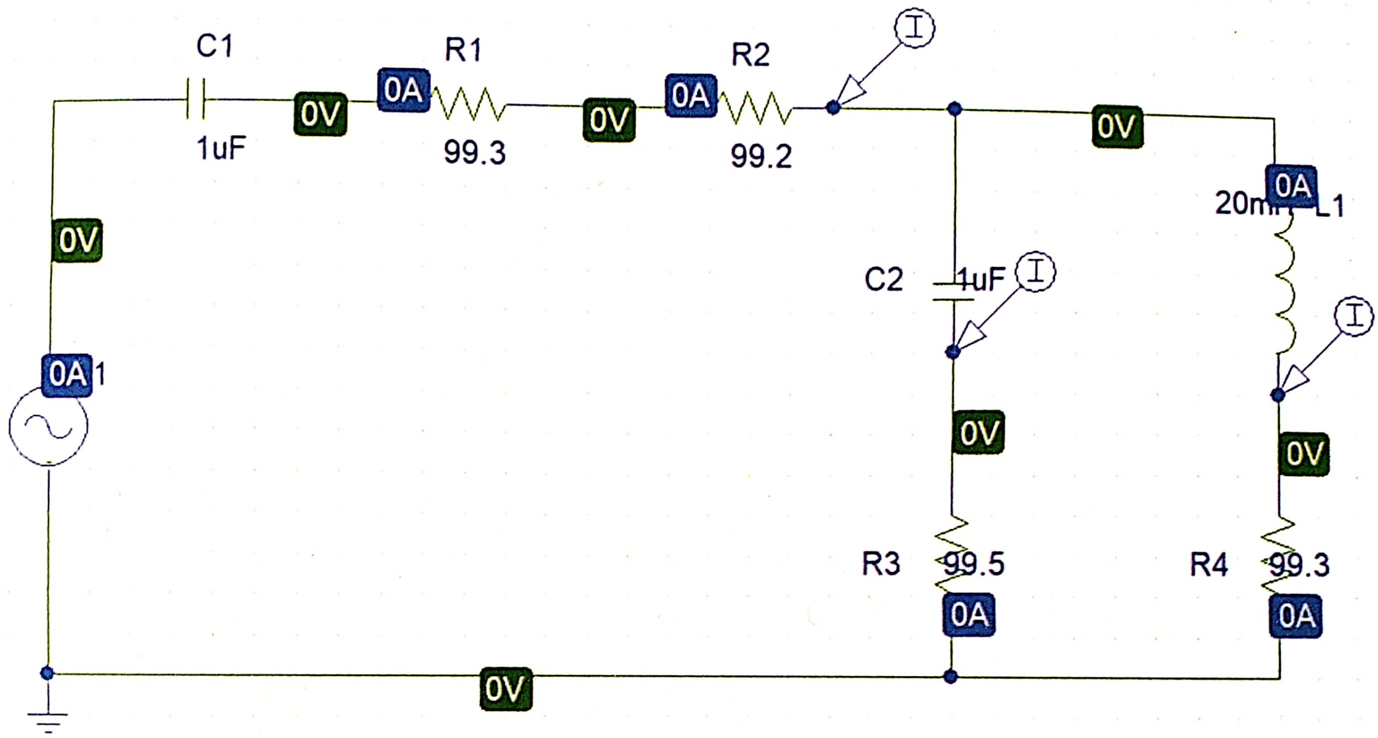
By this experiment, we have analysed RLC series-Parallel circuit. Also, we've veried KVL and KCL. This was completed through the help of Application PSPICE. We compared the values of experimental data and simulated data and percentage of error. This shows that, the experiment was -

→ conducted properly and some of the errors occured due to internal resistance or tolerance of each components.

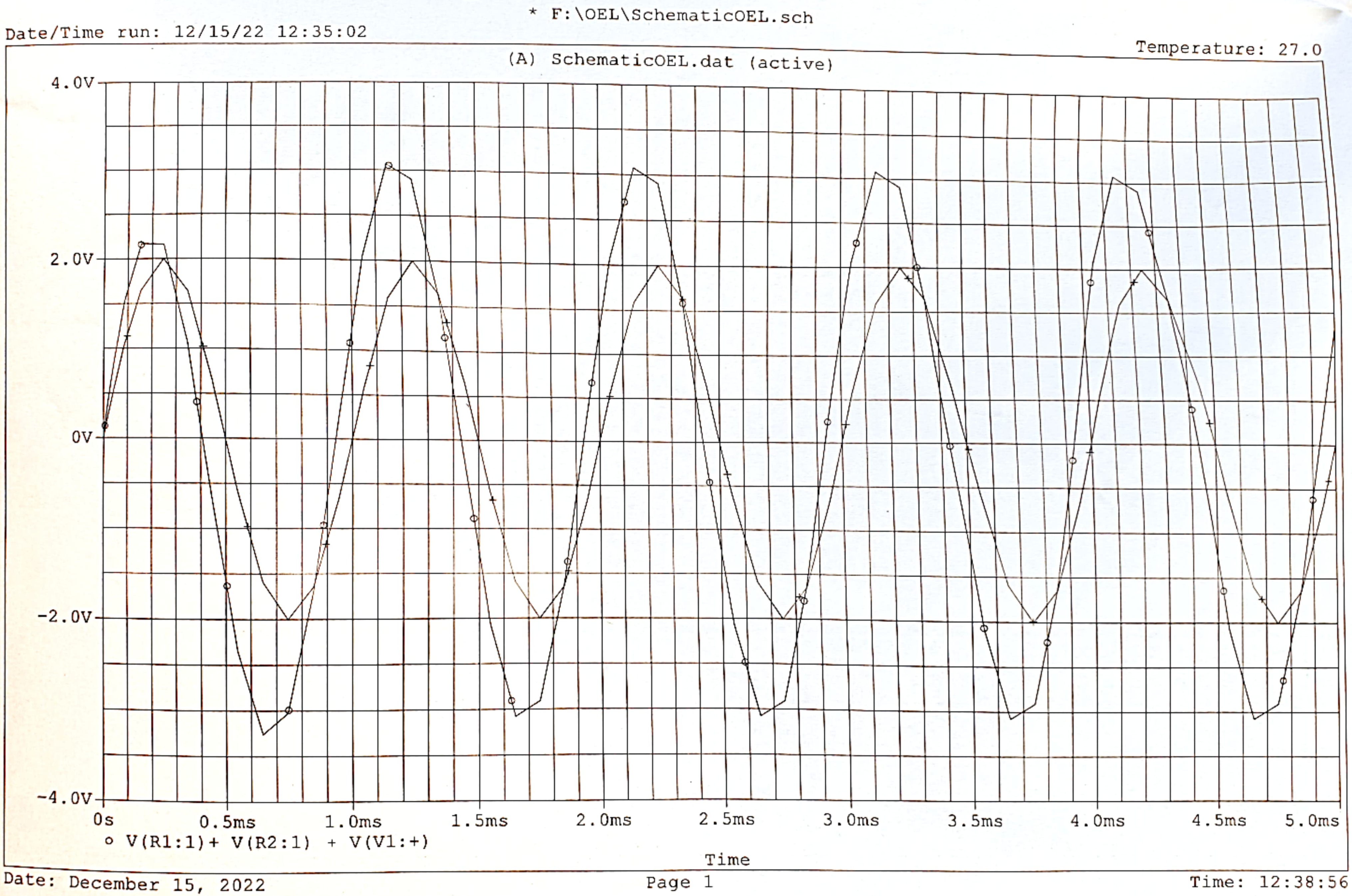
Reference:-

i) "Fundamental of Electric Circuit" by Alekzendre-Sadiku.

ii) "Alternating current circuit" by George f. Corcoran.



C1
1uF
R1
99.3
R2
99.2
C2
1uF
R3
99.5
R4
99.3
20mH
L1
0V
0A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Date/Time run: 12/15/22 12:35:02
Temperature: 27.0
(A) SchematicOEL.dat (active)
4.0V
2.0V
0V
-2.0V
-4.0V
0s
0.5ms
1.0ms
1.5ms
2.0ms
2.5ms
3.0ms
3.5ms
4.0ms
4.5ms
5.0ms
o V(R1:1)+ V(R2:1) + V(V1:+)
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