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FACULTY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

ELECTRICAL CIRCUIT LAB - 1

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Section: W, Group: 2

LAB REPORT ON

Analysis of RLC parallel circuit and verification of KCL in AC circuits

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Submitted By

Name	ID	Contribution
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2. PRANTO BISWAS	21-45026-2	Theory and Methodology, Data Table, Result and Calculation
3. KAZI ABDULLAH JARIF	22-46386-1	Result and Calculation, Discussion, Experimental Procedure
4. MD. NESAR UDDIN	22-46313-1	Precautions, Theory and Methodology, Discussion and Conclusion

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1.Introduction:

The RC & RL circuit is used to determine the input and output relationship of voltage and current for different frequencies. In RC series circuit the voltage lags the current by 90˚and in RL series circuit the voltage leads the current by 90˚.

An RLC circuit is an electrical circuit consisting of a resistor, an inductor, and a capacitor, connected in series. The RLC part of the name is due to those letters being the usual electrical symbols for resistance, inductance and capacitance respectively. Series RLC circuits are classed as second-order circuits because they contain two energy storage elements, an inductance and a capacitance.

The primary objectives of the lab experiment are-

- To determine the reactance of the RL and RC circuits and the impedance equation both practically and theoretically.
- To determine phase relationship between voltage and current in an RLC circuit.
- To draw the complete vector diagram.
- Design an RLC series circuit and verify KVL.

2.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 R_T is simply $1/G_T$. 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 Z_T of the circuit is then $1/Y_T$ that is, for the network of Fig.1

$$Y_T = Y_1 + Y_2 + Y_3 + \dots\dots\dots\dots + Y_N$$

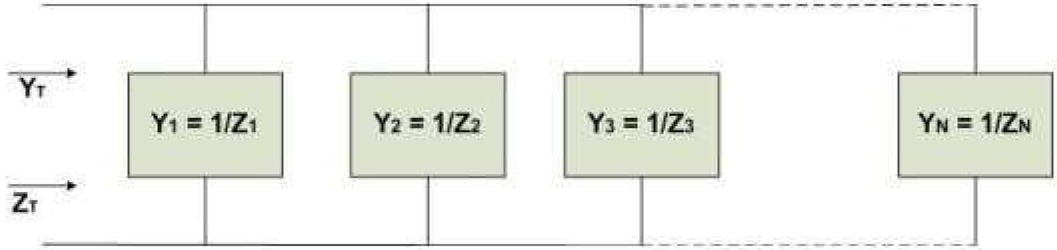

Fig.1: Parallel Branch Equivalent Admittance

Or, Since $Z = 1/Y$,

$$\frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3} + \ldots \ldots \ldots \ldots + \frac{1}{Z_N}$$

For two impedances in parallel,

$$\frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2}$$

$$Z_T = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

For three parallel impedances,

$$Z_T = \frac{Z_1 Z_2 Z_3}{Z_1 Z_2 + Z_2 Z_3 + Z_1 Z_3}$$

As pointed out in the introduction to this section, conductance is the reciprocal of resistance, and

$$Y_R = \frac{1}{Z_R} = \frac{1}{R\angle 0^\circ} = G\angle 0^\circ$$

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,

$$Y_L = \frac{1}{Z_L} = \frac{1}{X_L\angle 90^\circ} = \frac{1}{X_L}\angle -90^\circ$$

Defining

$$B_L = \frac{1}{X_L} \text{ (siemens, S)}$$

$$Y_L = B_L\angle -90^\circ$$

For inductance, an increase in frequency or inductance will result in a decrease in susceptance or, correspondingly, in admittance.

For the capacitor,

$$Y_C = \frac{1}{Z_C} = \frac{1}{X_C\angle -90^\circ} = \frac{1}{X_C}\angle 90^\circ$$

Defining

$B_C = \frac{1}{X_C}$ (siemens, S)

$Y_C = B_C \angle 90^{\circ}$

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

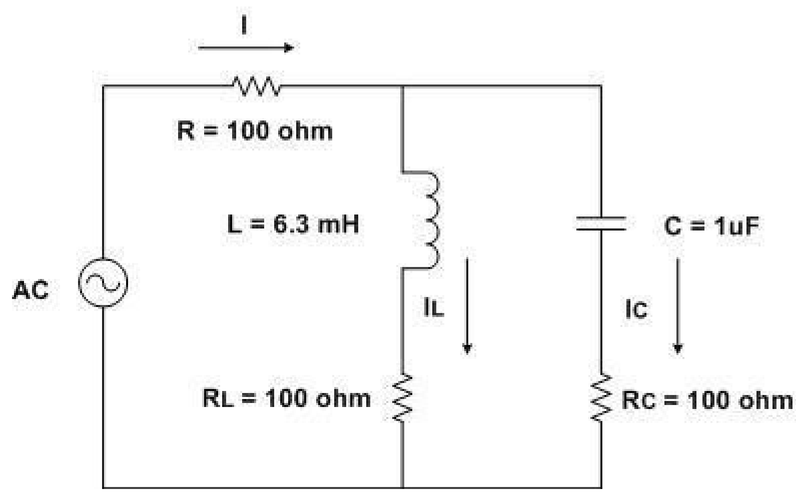

Fig. 2: Parallel Circuit KCL verification

The circuit of fig.2 represents a RLC parallel circuit where the Total Current I will divide into I_L and I_C in the parallel branches. If we apply KCL, $I = I_L + I_C$.

3.Apparatus:

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

4.Precautions:

- We have proceeded according to figure understanding the connections and check initially.
- Operated the signal/function generator smoothly and connected the probes perfectly.
- Calibrate the oscilloscope before connecting the channels across any components and ensure that there was no problem in the probes of the oscilloscope.
- Connected the components to the breadboard smartly to ensure the connections

5.Experimental Procedure:

- Constructed the circuit as shown in fig.1. Connected channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across RL
- we have Set the amplitude of the input signal 5V peak and the frequency at 1 kHz and selected sinusoidal wave shape.
- Measured the value of VRL and IL
- Determined phase relationship between E and VRL (i.e., θ_L) *
- Connected channel 2 of oscilloscope across RC.
- Determined phase relationship between the waves.
- Measured value of VRC and IC.
- Determined phase relationship between E and VRC (i.e., θ_C) *

- Added IL and IC.
- Measured VR and I connecting channel 2 across R.
- Compared IL+IC with the practically obtained value of I.
- Did the same work for setting input frequency 2 kHz and 4 kHz

Data Table:

Freq.(f) (kHz)	I (A)	θ (º)	I_R (A)	$θ_R$ (º)	I_L (A)	$θ_L$ (º)	I_C (A)	$θ_C$ (º)
1	0.02677+ j 0.00117	0.027∠2.5^0	0.03	∠2.5^0	0.02	∠ -24.47 ^{0}	0.01	∠ 54.985 ^{0}
2	0.03	0.03∠0.02^0	0.027	∠0.02^0	0.02	∠-38.62^0	0.013	∠38.76^0
3	0.0273-j8.156	0.0273∠ -1.714	0.03		0.0147	∠-47.847^0	0.0149	∠-44.153^0
4	0.0267-j1.167	0.0267∠ -2.495^0	0.0268	∠2.495^0	0.0123	∠-54.435^0	0.0123	∠-38.62^0

6.Result and Calculation

For F=1kHz

X_c=1/2πfC= 1/2π×1000×10^ (-6) =159.24Ω
X_L= 2πfL = 2π×1000×6.3×10^ (-3) = 39.584Ω
Z_R = R= 100Ω
Z_{RL} = R+ j X_L = 100+ j 39.584
Z_{RC} = R - j Xc = 100 - j 159.24
Z_T = Z_R + (Z_{RL} | | Z_{RC}) = 186.37- j 8.148
I=E/Z_T= 5/185.50- j 7.25= 0.02677+ j 0.00117 = 0.03 ∠ 2.5^0
I_L= (Z_{RC} ×I) / (Z_{RC} + Z_{RL}) = 0.01967- j 0.00895 = 0.02 ∠ -24.47 ^{0}
I_C= (Z_{RL} ×I) / (Z_{RC} + Z_{RL}) = 0.00709+ j 0.01012 = 0.01 ∠ 54.985 ^{0}

Now,

I_R = I_L + I_C = 0.02676 + j 0.00117 = 0.03 ∠ 2.5 ^{0}

We can see that I_R and I are almost same and this proves the KCL in AC circuit.
I_R≈I

7.Discussion:

1. In this experiment, RC, RL, RLC series circuits were constructed.
2. Input shape, frequency, wave shape was modified as required. I, V_R, V_L& V_C were measured where necessary.
3. The frequency input signal's value was adjusted several times. The obtained data was inserted into the table.
4. Relevant calculation was done using the experimental data. The analysis and verification were completed effectively.

   If we apply KCL, $I = I_L + I_C$

8.Reference:

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