Experiment No. 07

Aim: - To study and verify Resonance in R-L-C series circuit and measurement of resonance frequency.

Goal: -

- Define resonant frequency in series circuit.
- Understand series resonance phenomenon.

Apparatus: -

Sr. No.	Apparatus	Range	Qty.
01	Voltmeter		
02	Ammeter		
03	Resistance		
04	Chock coil		
05	Capacitor		
06	A.C. Supply		
07	Connecting wires		

Theory:-

Consider an AC-series circuit in which the resistance, inductance and capacitor are connected in series across a variable frequency A.C. source.
Let, impedance of the circuit,

$$Z = R + j(X_L - X_C)$$

Now, if the frequency is increased X_L increase and X_C decrease. Resistance is not dependent on Frequency of source. X_L can be made equal to X_C at one frequency.

$$|Z| = \sqrt{R^2 + (X_L - X_C)^2}$$

Where, $X_L = 2\Pi fL$ and $X_C = \frac{1}{2\Pi fC}$

Such a circuit shown in figure 1 is connected to an A.C source of constant supply voltage V but having variable frequency. The frequency can be varied from zero, increasing and approaching infinity. Since X_L and X_C are functions of frequency at a particular frequency of applied voltage X_L and X_C will be become equal in magnitude.

Since, $X_L = X_C$

$$X_L - X_C = 0$$

So, $Z = \sqrt{R^2 + 0}$, Z=R.

The circuit, when $X_L = X_C$ & hence Z = R is said to be in resonance in a series circuit since current I remains same.

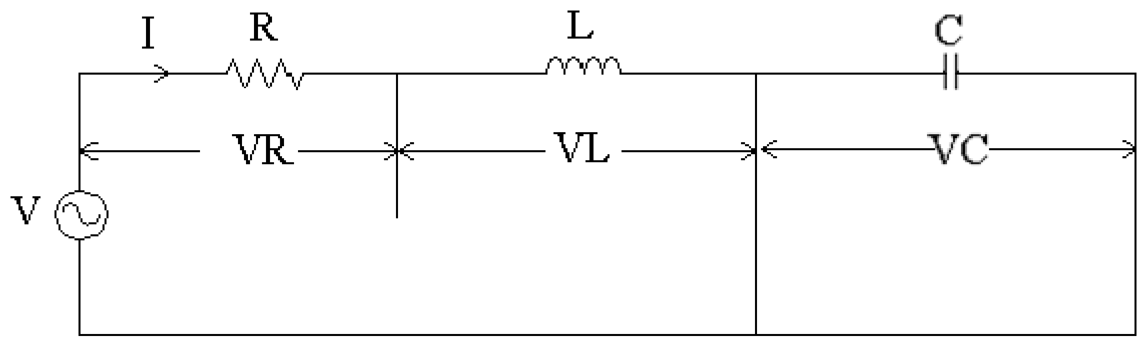

Figure 1

$$IX_L = IX_C$$

$$V_L = V_C$$

So at resonant V_L and V_C will be canceling out each other.

$$\text{The supply voltage, } V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$\mathrm{V} = \sqrt{\mathrm{V_R^2}}$$

$$V = V_R$$

The phasor diagram is shown in figure 2.

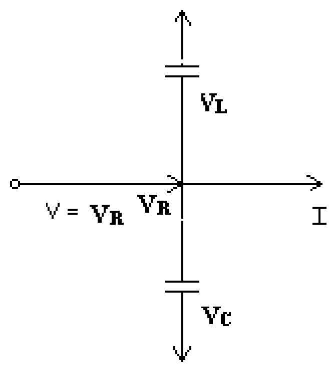

Figure 2

The phasor diagram shown in figure can be redrawn as shown in figure 3.

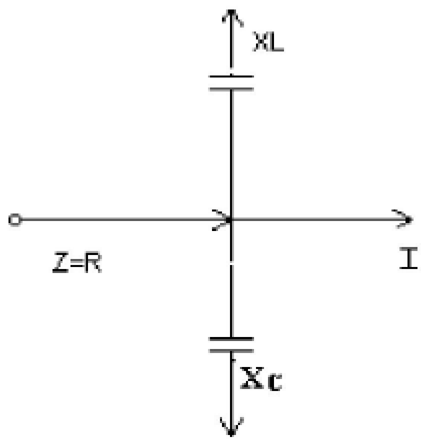

Figure 3

This is equal to supply voltage and current in phase as shown in figure 4.

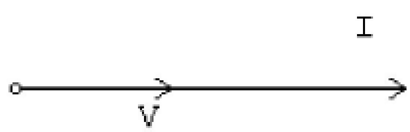

Figure 4

Now, Resonant frequency [At resonant condition X_L=X_C]

$$2\Pi f_r L = \frac{1}{2\Pi f_r C}$$

$${f_r}^2 = \frac{1}{4\Pi^2 LC}$$

$$f_r = \frac{1}{2\Pi\sqrt{LC}}$$

L=inductance in Henry

C=capacitance in farads

f_r = resonant frequency in HZ

EFFECT OF SERIES RESONANCE: -

1. When a series R-L-C circuit at resonance X_L= X_C, the net reactance of circuit is zero.
2. Z = R, then the impedance of circuit is minimum.

3. I= V/Z Here Z is minimum, so I is maximum.
4. Since, I is maximum, the power dissipated would be maximum $P= I^2R$.
5. $V_L=V_C$, $V=V_R$ i.e. since supply voltage is in phase with the supply current *I* .Hence power factor angle $\Phi = 0$. And circuit power factor $\cos\Phi = \cos 0 = 1$

Circuit Diagram:-

Procedure: -

- Connect the circuit as per circuit diagram.
- Set suitable value of the parameter from decade box and switch on the supply. Adjust minimum frequency of the supply.
- Increase the frequency gradually and note down the current flowing through the circuit.
- Continue to increase the frequency and not down the reading until the current increases to maximum and starts decreasing.
- Plot the graph of current v/s frequency.
- Obtain the resonance frequency from graph and also calculate resonance frequency from equation.

Observation Table:-

Sr. No.	Frequency in Hz	Current mA
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		
13		
14		
15		

Calculations:-

Conclusion:-