(AC 2-6) Series R-L-C Resonant Circuit

Aim of experiment

1. Investigation of the characteristics of the series resonant circuit.
2. Determination of the resonance frequency.

Apparatus

Function generator – Capacitor – Coil – Resistor – Ammeter.

Theory of experiment

Series Resonance circuits are one of the most important circuits used in electrical and electronic circuits. They can be found in various forms such as in AC mains filters, noise filters and also in radio and television tuning circuits.

Consider the simple series RLC circuit below.

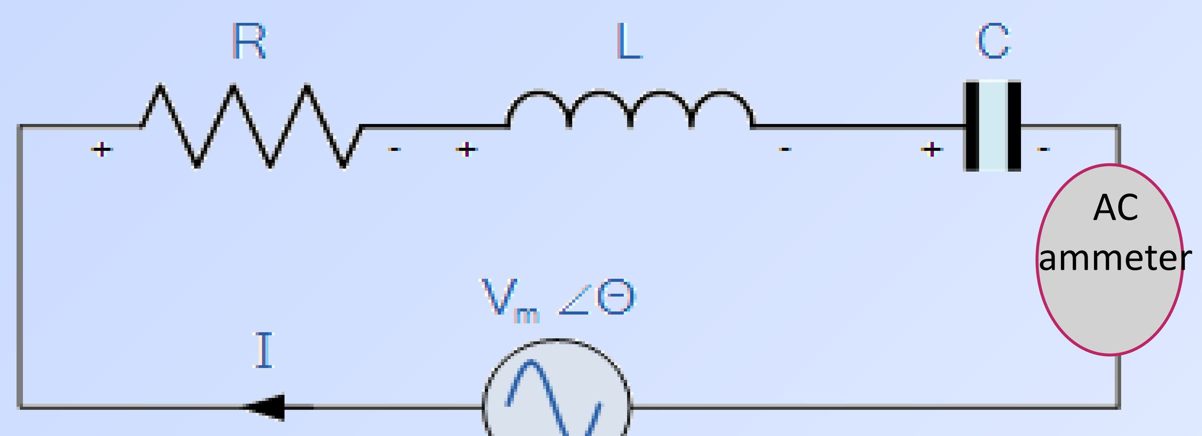


Figure 1 Series RLC Circuit

Figure 1 shows a resistor, a coil, and a capacitor connected in series with an AC generator.

The instantaneous current has the same value at all points of the circuit. The inductive reactance X_L and capacitive reactance X_C in the circuit can be computed using the formulas:

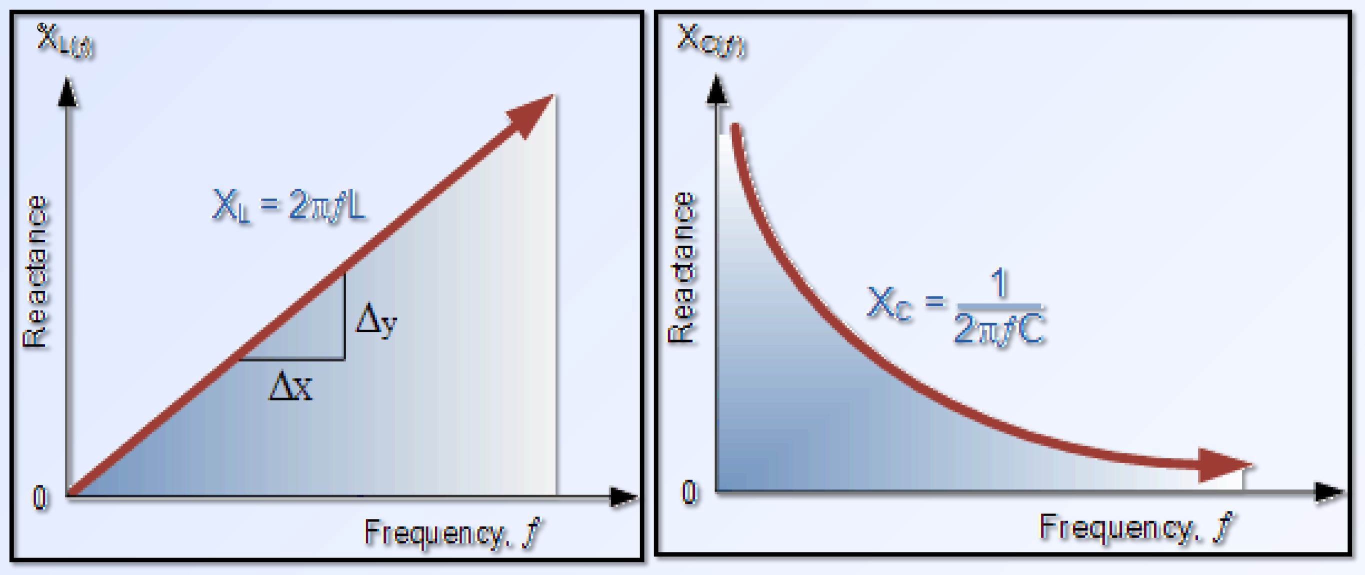
$$X_C = 1/2\pi fC \quad \text{And,} \quad X_L = 2\pi fL$$

The formula for the total circuit impedance is:

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + (2\pi fL - \frac{1}{2\pi fC})^2}$$

Z, R, X_L , and X_C are measured in ohms when L in henry and *C* in farad.

From above equations one finds that inductive reactance X_L has linear relation with frequency, and capacitive $_L$ reactance X_C has hyperbolic relation with frequency as shown in *figure 2* below



(a) Inductive Reactance **b)** Capacitive Reactance

Figure 2 Reactance against frequency

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The value of these resistances depends upon the frequency of the supply. At a higher frequency X_L is high and at a low frequency X_C is high. Then there must be a frequency at which the effect of the reactance X_L and X_C cancel each other, thereby making a series L_C combination acts as a short circuit with the only opposition to current flow in a series resonance circuit being the resistance, *R.*

In complex form, the resonant frequency is the frequency at which the total impedance of a series RLC circuit becomes purely "real". Then at resonance the impedance of the series circuit is at its minimum value and equal only to the resistance, *Z=R* of the circuit.

The circuit impedance at resonance is called the "dynamic impedance" of the circuit. X_C (typically at high frequencies) or X_L (typically at low frequencies) will dominate respectively either side of resonance as shown below, figure 3.

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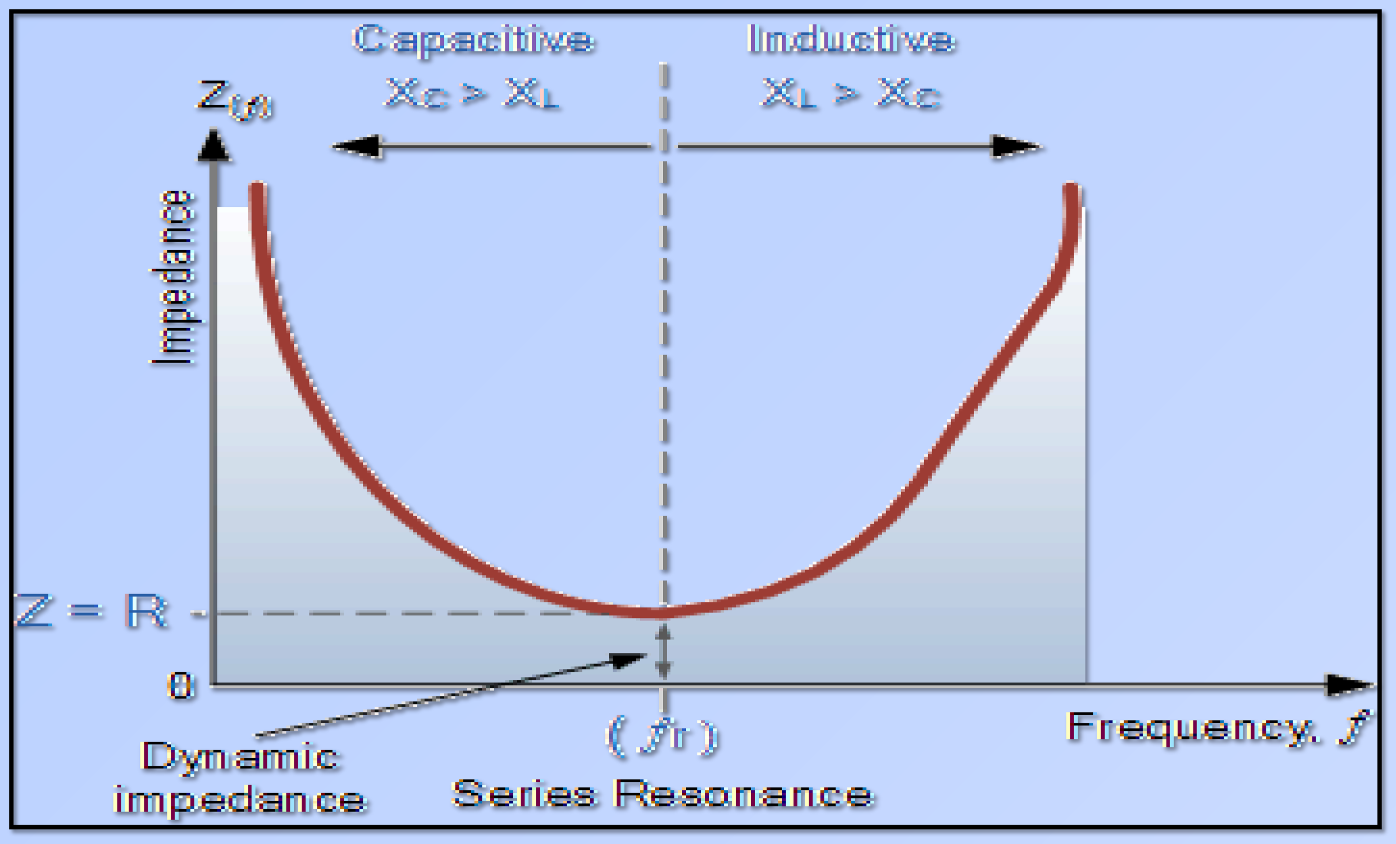


Figure 3 Impedance in a Series Resonance Circuit

On another words, the two voltages V_L and V_C at resonance must also be opposite and equal in value, thereby cancelling each other. Then in a series resonance circuit, *figure 4*, $V_L = -V_C$, therefore, $V = V_R$.

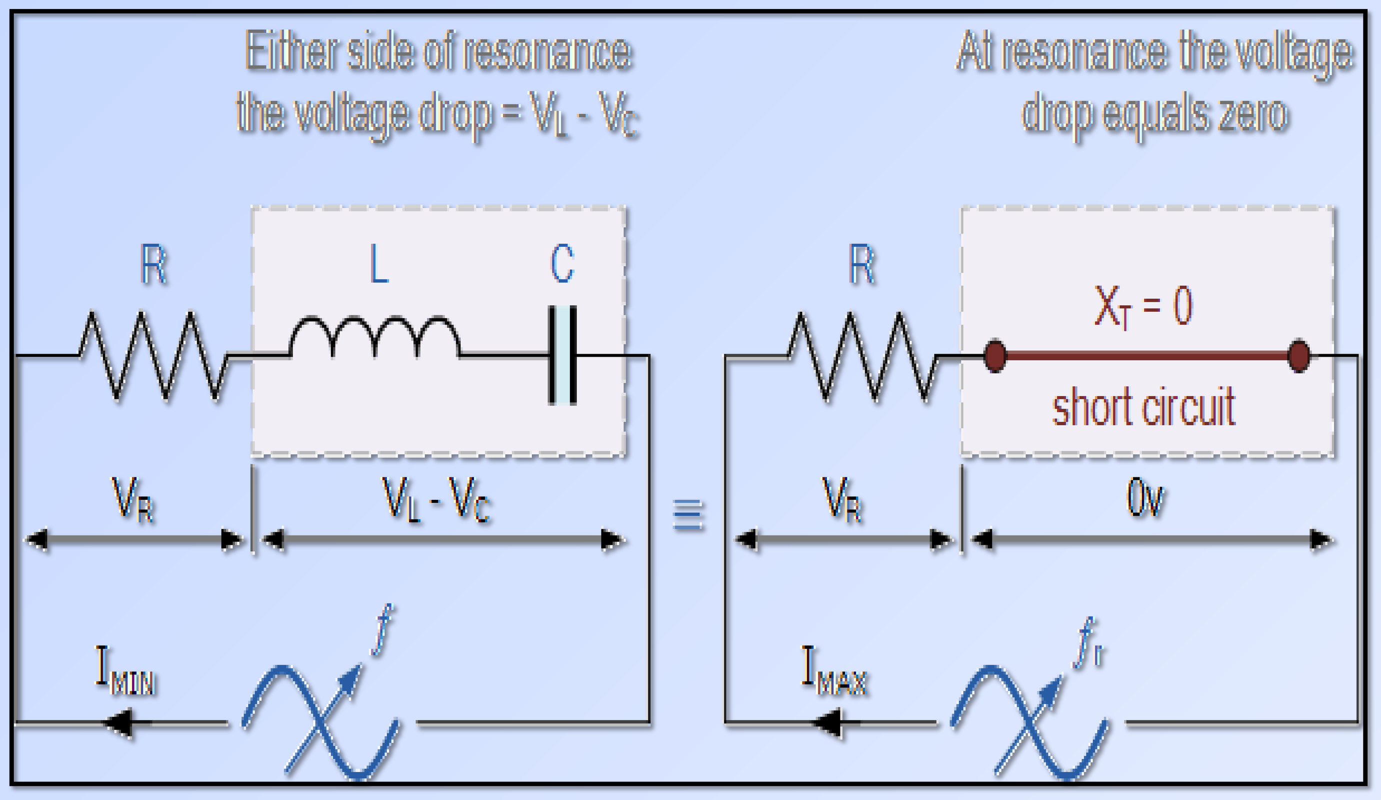
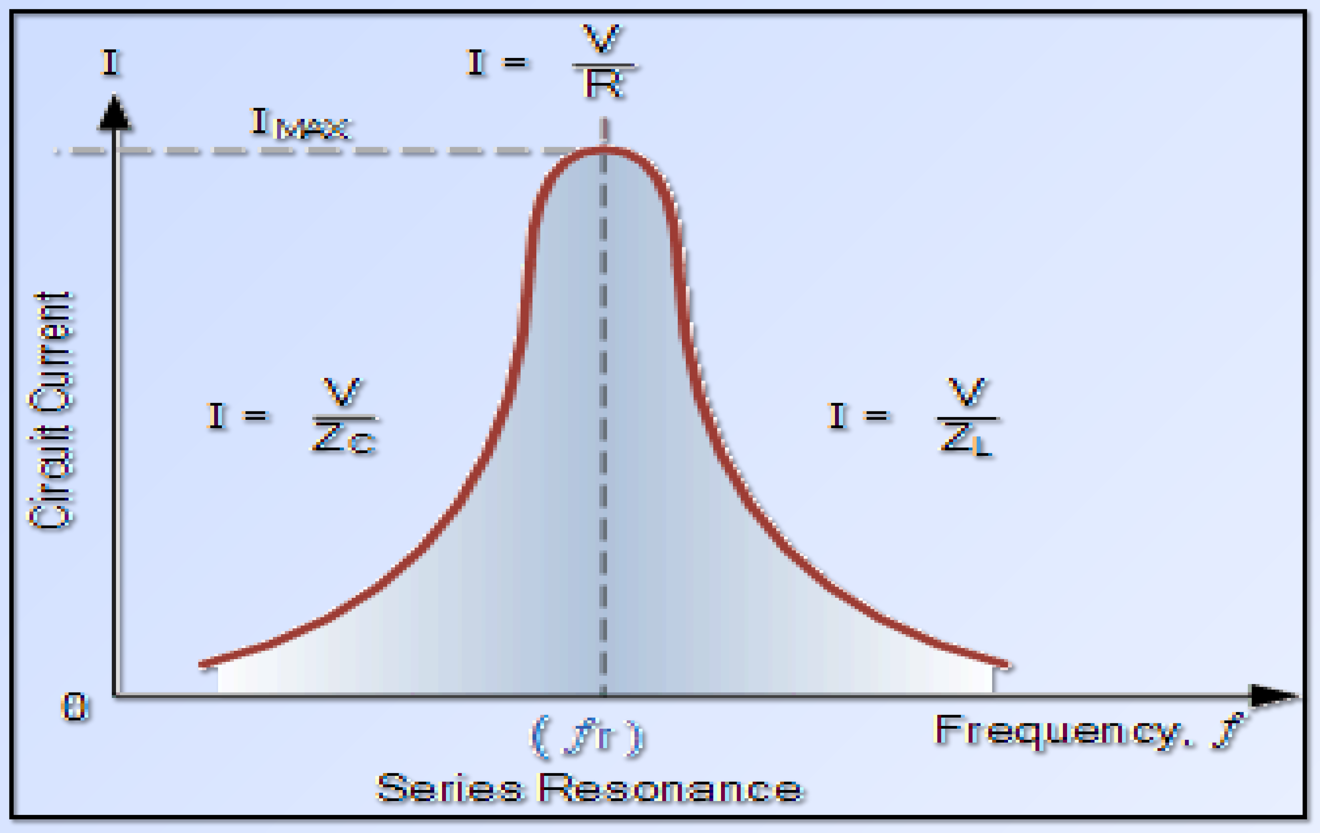


Figure 4 Series RLC Circuit at Resonance

Since the current flowing through a series resonance circuit is the voltage divided by impedance, at resonance the impedance; Z is at its minimum value, (=R). Therefore, the circuit current at this frequency will be at its maximum value of V/R as shown below, *figure 5*.



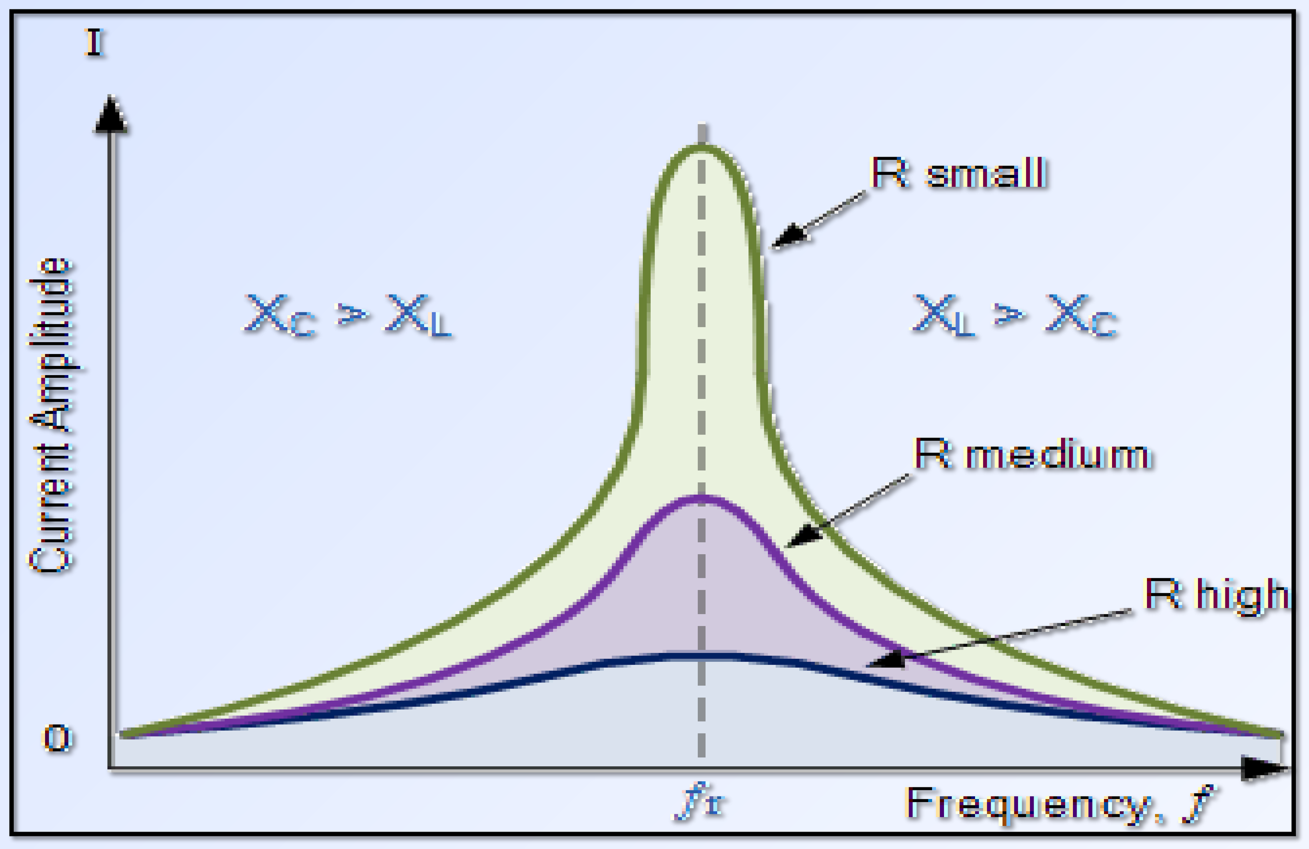


Figure 5 Series circuit current at resonance at different resistances

Procedures

1. Turn on and set the generator range switch to the high position.
2. Slowly turn the frequency knob and measure the corresponding current in each case.
3. Draw a graph between the frequency on x-axis and current on y-axis.
4. Compute the resonant frequency of the circuit. f_r = ……….Hz, and compare it with that obtained from the curve .

Results

ƒ (Hz)	*I (A)*	*ƒ(Hz)*	*I (A)*	*ƒ (Hz)*	*I (A)*

f_r = ……….Hz

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