OBJECTIVE

To determine the resonant frequency, self-inductance and the quality factor of the coil in the series and parallel circuits.

PRINCIPLE

A coil of self-inductance ‘L’ is connected in series with a capacitance ‘C’ and a resistance R. This circuit is called as a series LCR circuit. If \( V_i \) is the driving voltage a current, \( I \) will flow in the circuit. At an angular frequency \( \omega_0 \) of the ac source, the current, I will be in phase with the voltage \( V \). This condition is called as resonance and the circuit is referred to as a Series Resonant Circuit. If the inductance \( L \) is connected in parallel with a capacitance \( C \) and a resistance \( R \), the circuit is called as a parallel LCR circuit.

SPECIFIC REQUIREMENT

Audio frequency oscillator, inductance coil, capacitance box, resistance box, milliammeter, multimeter.

Formulae

1. \( \omega_0 = \frac{1}{\sqrt{LC}} \), \( f_r = \frac{1}{2 \pi \sqrt{LC}} \)

2. \( L = \frac{1}{4 \pi^2 f_R^2 C} \)

3. \( Q = \frac{\omega_0 L}{r} \)

4. \( Q = \frac{2 \pi f_R L}{r} \)

where \( \omega_0 \) is the angular frequency is hertz.
\( L \) is the inductance of the coil in Henry.
\( C \) is the capacitance of the capacitor is micro farad.
\( R \) is the resistance of the resistor in ohm.
\( f_R \) is the resonant frequency of the series or parallel resonant circuit in hertz.
Q is the quality factor of the coil.

$r$ is the resistance of the coil in ohm.

**PROCEDURE**

**Series Resonant Circuit**

(a) The capacitance (C), inductance (L), resistance (R) and a milliammeter (mA) are connected in series with an AFO as shown in the diagram 1.

(b) The capacitance (C) is set to be 0.1 μF and resistance (R) is set as 50 ohms.

(c) The audio frequency oscillator is adjusted to a minimum value of 1 kHz.

(d) The current shown by milliammeter is noted.

(e) Keeping the C and R values as a constant, the frequency of AFO is increased in steps of 500 Hz and the corresponding milliammeter readings are noted.

(f) The same procedure is repeated for R = 100, R = 150 and R = 200 ohms, for the same range of frequency and the readings are tabulated.

(g) A graph is drawn with frequency along the X-axis and the current along the Y-axis. The frequency at which the current is maximum is the resonant frequency.

**Diagram 1:**

![Diagram 1](image1.png)

**Graph 1:**

![Graph 1](image2.png)
TABLE 1.1: To determine resonant frequency in series mode

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Frequency (Hz)</th>
<th>Current (mA)</th>
</tr>
</thead>
</table>

PARALLEL RESONANT CIRCUIT

PROCEDURE

(a) The inductance (L), the resistance (R), are connected in series, and this is connected in parallel to the capacitor (C).

(b) The milliammeter (mA) and AFO are connected as shown in diagram 2.

Diagram 2:

(c) The capacitance (C) is set to be 0.1 μF and the resistance (R) is set to be 50 ohms.

(d) The audio frequency oscillator is adjusted for a minimum value of $f = 1$ kHz.

(e) The current in the circuit shown by the milliammeter is noted.

(f) Keeping the C and R values to be constant, the frequency is increased in steps of 500 Hz and the milliammeter readings are noted.

(g) The resistance of the inductance coil ($r$) is measured using a multimeter.

(h) The procedure is repeated for R values of 100, 150 and 200 ohms for the same range of frequency and readings are tabulated.

(i) A graph is drawn with the frequency along the X-axis and the current along the Y-axis. The frequency at which the current is minimum is the resonant frequency.

TABLE 1.2: Parallel resonant circuit to determine the resonant frequency

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Frequency (Hz)</th>
<th>Current (mA)</th>
</tr>
</thead>
</table>

Series and Parallel Resonant Circuits
Graph 2:

CALCULATION

Series Resonant Circuit

(a) Resonant frequency from graph (1) is found to be \( f_R = \ldots \) Hz.

\[ L = \frac{f}{4\pi^2 f_R^2 C} \]

‘C’ is the capacitance set is \( \mu F \).

\( L = \ldots \text{ milli Henry} \).

(b) Quality factor of coil \( Q = \frac{2\pi f_R L}{r} \frac{1}{4\pi^2 f_R^2 C} \)

where ‘\( r \)’ is the resistance, and it is practically the resistance of the inductance coil and is measured using a multimeter.

CALCULATION

Parallel Resonant Circuit

(a) The resonant frequency \( f_R \) is noted from the graph is Hertz.

\( L = \ldots \text{ milli Henry} \)

where ‘C’ is the capacitance set in micro farads.

(b) \( Q = \frac{2\pi f_R^2 L}{r} \)

where ‘\( r \)’ is the resistance of the inductance coil and is measured using a multimeter.

RESULT

For a Series Resonant Circuit

1. The resonant frequency is \( \ldots \) Hz.
2. The inductance of the coil was found to be $L = \ldots\ldots\ldots\text{mH}$.
3. Quality factor was calculated to be $Q = \ldots\ldots\ldots$.

**For a Parallel Resonant Circuit**

1. The resonant frequency $f_R = \ldots\ldots\ldots\text{Hz}$.
2. The inductance of the coil was found to be $L = \ldots\ldots\ldots\text{mH}$.
3. Quality factor was calculated to be $Q = \ldots\ldots\ldots$. 