Ministry of Higher Education and Scientific Research

Salahaddin University-Erbil

College of Education

Department of Physics

First Stage/ Second Semester

Laboratory of Electricity and Magnetism
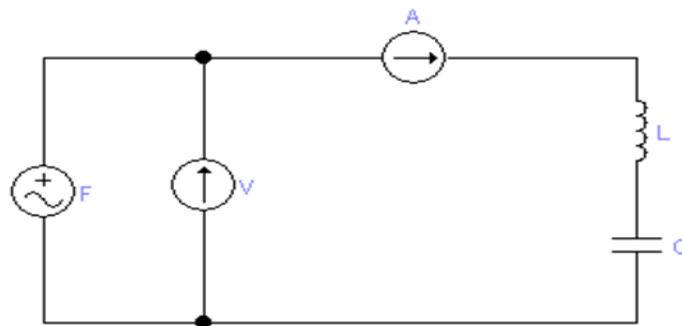
Group (   )

Full Name:

Experiment Number: (4)

Name of Experiment: Resonance Circuit

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Resonance Circuit

The Purpose of this Experimental:

Study the resonance (series and parallel) in the A.C circuits, and then calculate the resonance frequency.

Theory:

A: Series Resonance: if the electrical circuit contain both of coil and capacitance and resistance connect seriously the go in the resonance state whenever the impedance of the circuit very small, the impedance of the any circuit contain these three elements connect seriously by this equation.

$$Z = R + i(X_L - X_C) \ \dots (1)$$

Which contain the imaginary part i the amplitude of the impedance given by:

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

From the above equation it is clear that the wonted condition make the impedance very small is:

$$X_L - X_C = 0 \dots (3)$$

By using both of the X_L and X_c in the equation (3) we obtain:

$$2\pi f L - \frac{1}{2\pi f C} = 0 \dots (4)$$

We can find the frequency which make the $X_L = X_C$, this frequency is called the resonance frequency, and

$$f_0 = f = \frac{1}{2\pi\sqrt{LC}} \ \dots \ (5)$$

This mean that if the frequency of the circuit is equal to the resonance frequency, the impedance of the circuit becomes equal to the resistance and the current becomes maximum.

B: Parallel Resonance: if the electrical circuit contains both of the coil, capacitance and resistance and they connect parallel which each other's, the phase relation of impedance for this case is equal to

$$Z = \frac{Z_L Z_C}{Z_L + Z_C} = \frac{(R_L + iX_L)(-iX_c)}{(R_L + iX_L) - iX_C} \quad \ldots \quad (6)$$

$$\frac{(R_L + iWL)(-\frac{1}{WC})}{(R_L + i\left(WL - \frac{1}{WC}\right)} \quad \ldots \quad (7)$$

The condition in this case is different with the first case; also the curve plotted between the impedance and frequency is difference with parallel case.

The relation of the resonance frequency in this case is not simply as a comparison between the first cases, therefore we only write the last equation with one the derivative

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R_L^2}{L^2}} \quad \ldots \quad (8)$$

But the value of RL is much small which make the quality ($\frac{R_L^2}{L^2}$) more small with the quantity ($\frac{1}{LC}$), therefore can be neglected and we obtain

$$f_0 = \frac{1}{2\pi\sqrt{LC}} \quad \ldots \quad (9)$$

and this the same result of the series resonance.

Apparatus:

1. Generator Function.
2. Ammeter (mA)
3. Voltmeter (V)
4. Resistance (R=50Ω , R=100Ω, R=200Ω and as you like)
5. Coil (L=9mH, L=2mH and as you like)
6. Capacitor (2µF, 1µF, 0.5µF and as you like)
7. Set of wires.

Experimental Method (Procedure):

A. Series Resonance:

1. Connect the electrical circuit as show in figure (1).
2. Make the voltage of the oscillator constant and change the value of the frequency and record the current value.

f (Hz)	I(mA)

3. Draw the curve between (I on the Y-axis) and (F on the X-axis), show in figure (2).
4. From this curve find the resonance frequency (F_0) practically and theoretically from the equation (5).
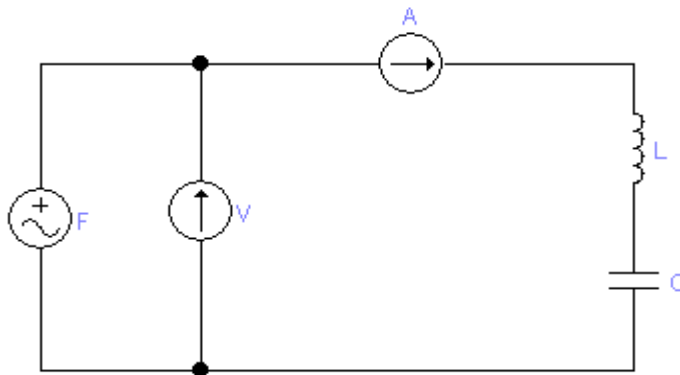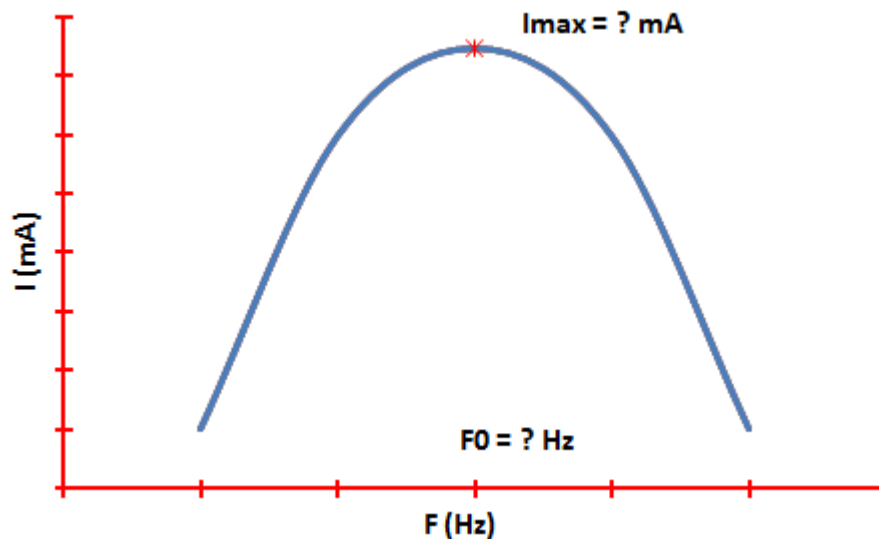
Figure (1): The resonance series circuit.

Figure (2): The current against of frequency in the series circuit.

B. Parallel resonance:

1. Connect the electrical circuit as show in figure (3).
2. Make the value of the oscillator constant and change the value of the frequency and record the current value

f (Hz)	I(mA)

3. Draw the curve between (I on Y-axis) and (F on X-axis), show in figure (4).
4. From this curve find the resonance frequency (F_0) practically and theoretically from the equation (9).
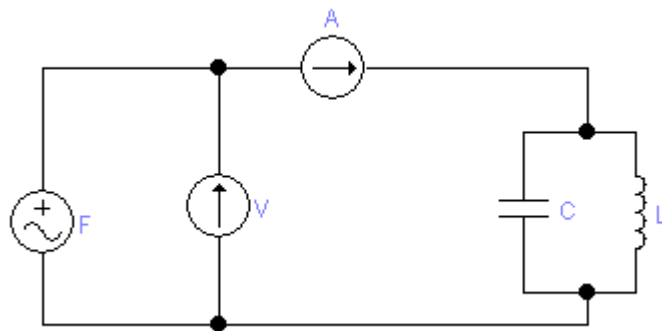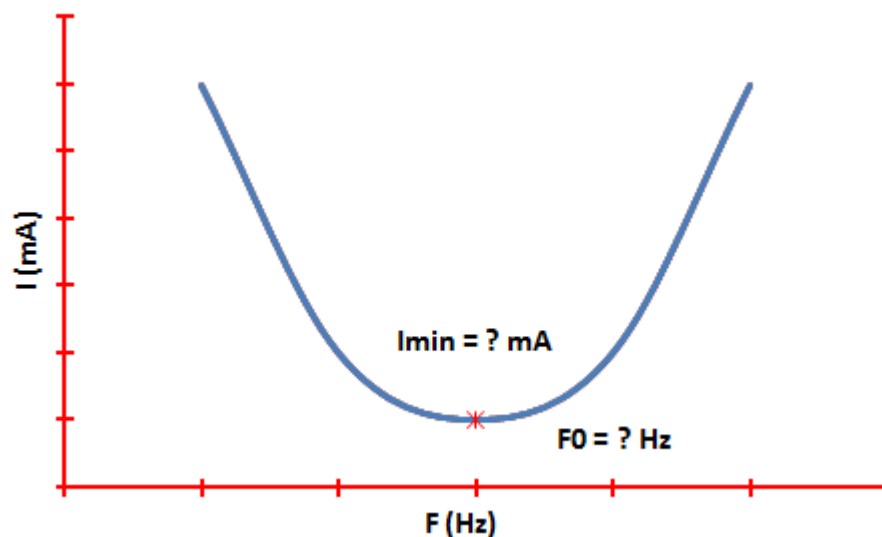

Figure (3): The resonance parallel circuit.

Figure (4): The current against of frequency in the parallel circuit.
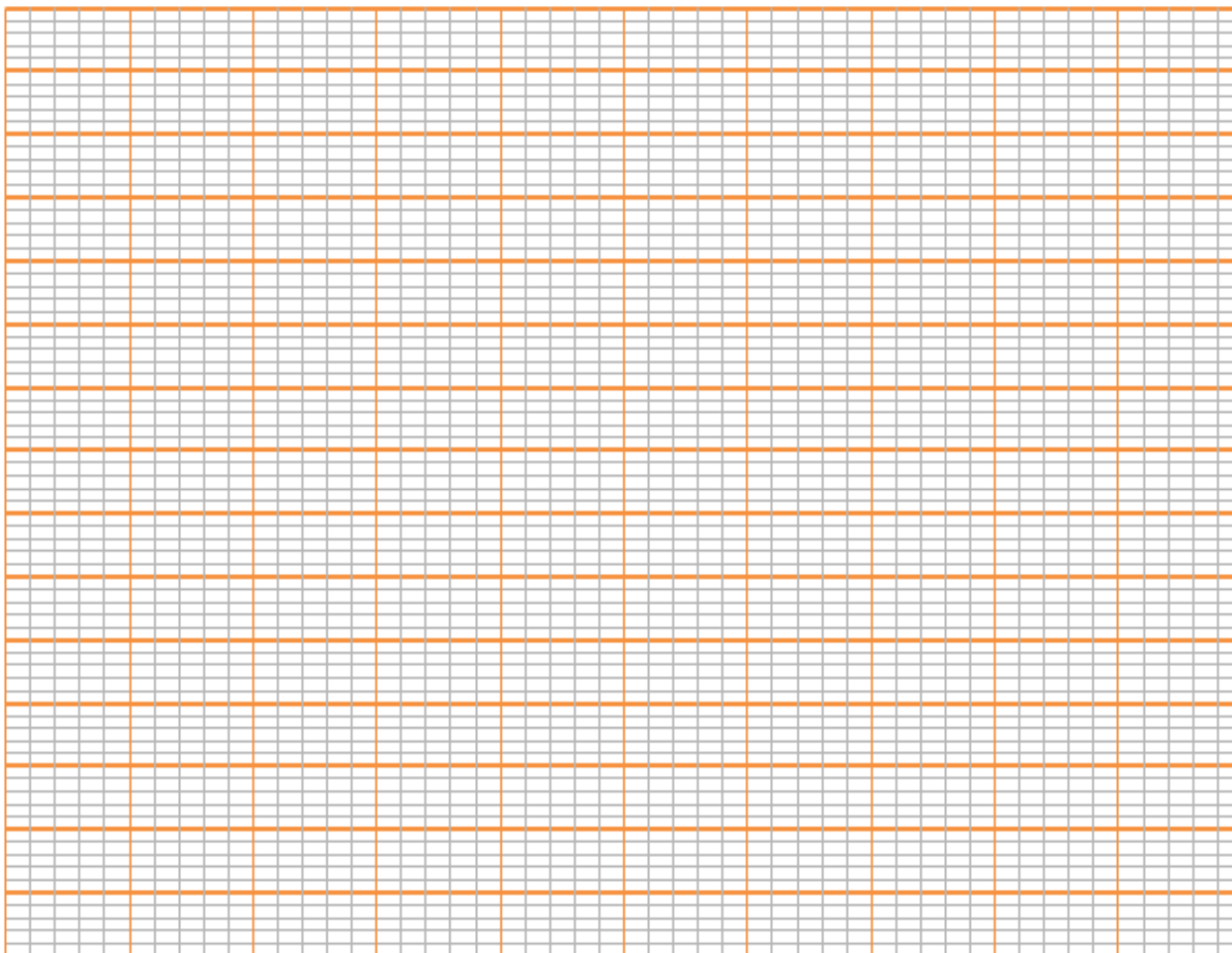
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Data and Calculate:

Table 1:

f (Hz)	I (mA)

L **(By using Coil)**	$L =$ ....
C **(By using Capacitor)**	$C =$ ....
L **(By using equation)**	$f_0 = \dfrac{1}{2\pi\sqrt{LC}} =$ ....
f_0 (**experiment**): **at the Maximum current** $f = f_0$ **(By using Graph)**	$f_0 =$ .... **at** $I_{max} =$ ....
$Error_{f_0} = \varepsilon_{f_0} =$	$= \dfrac{\left\| f_{0_{th}} - f_{0_{exp}} \right\|}{f_{0_{th}}} \times 100\%$ $= \dfrac{\| \qquad\qquad \|}{\qquad\qquad} \times 100\%$ $=$

Graph 1:

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$f_0 = \underline{\hspace{4cm}}$$

$$= \underline{\hspace{4cm}}$$

$$=$$

$$f_0 = \ \dots\dots\dots \quad \textbf{at} \ \ I_{max} = \ \dots\dots\dots$$

Data and Calculate:

Table 2:

f (Hz)	I (mA)

L (By using Coil)	$L = $ ....
C (By using Capacitor)	$C = $ ....
L (By using equation)	$f_0 = \dfrac{1}{2\pi\sqrt{LC}} = $ ....
f_0 (**experiment**): **at the Minimum current** $f = f_0$ (By using Graph)	$f_0 = $ .... **at** $I_{min} = $ ....
$Error_{f_0} = \varepsilon_{f_0} = $	$= \dfrac{\left\| f_{0_{th}} - f_{0_{exp}} \right\|}{f_{0_{th}}} \times 100\%$ $= \dfrac{\|\qquad\qquad\qquad\|}{\qquad\qquad\qquad} \times 100\%$ $=$

Graph 2:

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$f_0 = \underline{\hspace{5cm}}$$

$$= \underline{\hspace{4cm}}$$

$$=$$

$$f_0 = \quad \text{........} \quad \textbf{at} \ I_{min} = \quad \text{........}$$

Result and Discussion: