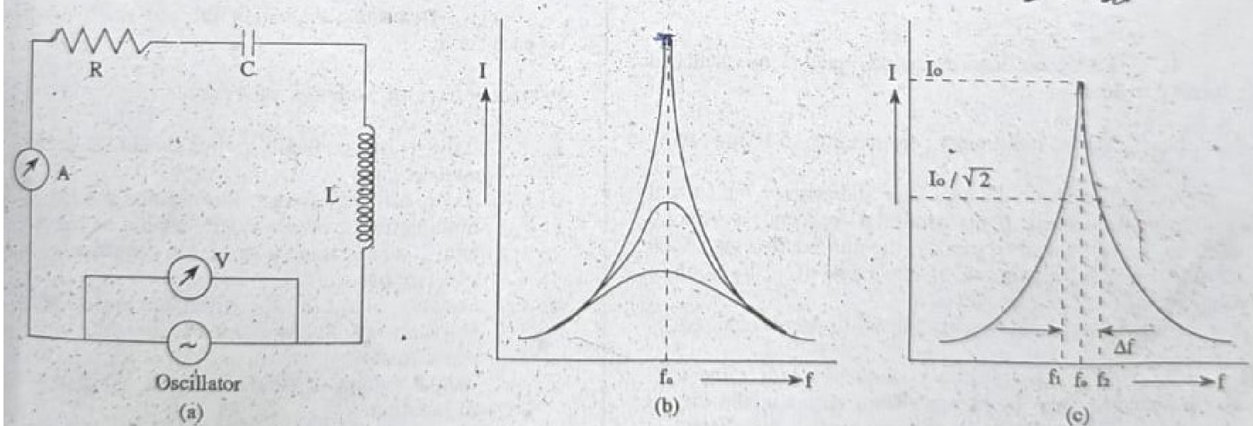
PHY-321 "Applied Physics" 3(2-1)
Class: ADP (Computer Science)-(Morning)-1st Semester

Practical no.1:
"To study the behavior of RLC Series circuit and determination of its resonance frequency"

Expt.No.37. **To study the characteristics of RLC series (acceptor) circuit.**

Apparatus. Audio oscillator, resistors (100 Ω, 500 Ω), 1000 Ω; all 0.25 watt), capacitor (0.01 μf), inductance (200 mH or any available value), two multimeters with ac current and voltage ranges.



Observations and calculations.

Value of inductance used = L = ... henry
Value of capacitance used = C = ... farad
Resonance frequency calculated
from above values = $f_0 = \dfrac{1}{2\pi\sqrt{LC}}$ = ... hertz.
Oscillator output voltage = ... volt.

↓ R ohms	No. of Obs. →		1	2	3	4	5	6	7	8	9	10
R_1 =	Frequency	Hz										
	Current	mA										
R_2 =	Frequency	Hz										
	Current	mA										
R_3 =	Frequency	Hz										
	Current	mA										

Results from graph:

1. Resonance frequency $= f_0 = \ldots\ldots$ Hz
2. Lower limit frequency $= f_1 = \ldots\ldots$ Hz
3. Upper limit frequency $= f_2 = \ldots\ldots$ Hz
4. Bandwidth $= f_2 - f_1 = \Delta f = \ldots\ldots$ Hz
5. Quality factor $= Q = \frac{f_0}{\Delta f} = \ldots\ldots$

Procedure.

1. Select a suitable combination of R, L and C.

   Take R in the range $100\Omega - 1000\Omega$.
   Take L in the range 100 mH – 500 mH.
   Take C in the range 0.001 µf – 0.1 µf.

2. Connect the circuit as shown in figure (a).

3. Set the oscillator output at a low voltage, say, 1 volt.

4. Set the oscillator frequency equal to the calculated resonance frequency.

5. Set the multimeter current range to 10 mA, AC.

6. Switch on the oscillator and observe the current flowing in the circuit. If the oscillator frequency is exactly equal to the resonance frequency, the current flowing in the circuit should be maximum. It can be verified by slightly adjusting the oscillator frequency.
   Adjust the current range of the multimeter if required.

7. Bring the oscillator frequency to a value well below the resonance frequency. The current in the circuit should fall to a very low value compared to the current at resonance.

8. Increase the frequency in regular steps of say, 500 to a value well above the resonance frequency till the current falls to about the same value as it was with the lowest frequency.
   For each value of frequency, note the corresponding current.
   Make sure that the out put voltage of the oscillator remains constant for all the frequencies.

9. Record two more sets of observations for different values of R.

10. Plot current values against frequency for each set and obtain the curves as shown in figure (b). For small value of R peak current is high and it is low for large value of R. Resonance frequency is same for all curves.

    In case the frequency variation is very large, the curve should be plotted between I and $\log f$.

11. Determine the bandwidth and quality factor for each curve.

Precautions and sources of error

1. Low resistance flexible wires should be used for connections.
2. Loose and dirty connections must be avoided.
3. Suitable range of multimeter should be selected and it should remain same for complete set of observations.
4. Output voltage of the oscillator must remain constant at all frequencies for one set of observations.
5. Output voltage of the oscillator should be as low as possible.

Viva Voice :

Q.1. Why is a RLC series circuit called an acceptor circuit?

Ans. A given combination of R, L and C in series allows the current to flow in a certain frequency range only. For this reason it is known as an acceptor circuit i.e., it accepts some specific frequencies.

Q.2. What is meant by resonance in RLC series circuit?

Ans. For a certain frequency of the sinusoidal voltage applied to the RLC series circuit, the current flowing in the circuit has a maximum value. This phenomenon is known as resonance.

Q.3. Why is the current maximum at resonance in a RLC series circuit?

Ans Because the impedance of the circuit is minimum at resonance.

At resonance the only effective opposition to the flow of current is due to the resistance used and the dc resistance of the inductance.

Q.4. What is meant by response curve of a RLC series circuit?

Ans. When RLC series circuit is excited by a sinusoidal voltage of constant magnitude, the current changes with frequency of the applied voltage. A graph between current and frequency is known as the response curve, Fig.(c).

Q.5. What are lower and upper limit frequencies?

Ans. In a RLC series circuit, the current is maximum at resonance frequency. At all other frequencies the current has a lower value. The frequencies f_1 and f_2, below and above the resonance frequency at which the current falls down to $\frac{1}{\sqrt{2}}$ or 0.707 times of its maximum value are known as lower and upper limit frequencies respectively, Fig.(c).

Q.6. What is bandwidth of RLC series circuit?

Ans. The frequency range between upper and lower limit frequencies is called bandwidth, i.e.,

$$\text{Bandwidth} = \Delta f = f_2 - f_1$$

Q.7. What is quality factor?

Ans. It is the ratio between the resonance frequency and the bandwidth, i.e.,

$$\text{Quality factor} = Q = f_o / \Delta f$$

Q.8. What is meant by suitable range of a meter?

Ans. The most suitable range for measuring a certain quantity (current, voltage and resistance etc.) is the one for which full scale deflection is nearly equal to the value being measured.

Specimen set of observations:

$R = 12\Omega$, $C = 0.01\ \mu f$, $L = 180$ mH

Output of oscillator fixed at 1.0 volt.

Calculated resonance frequency = 3750 Hz

Resonance frequency from graph = 3800 Hz

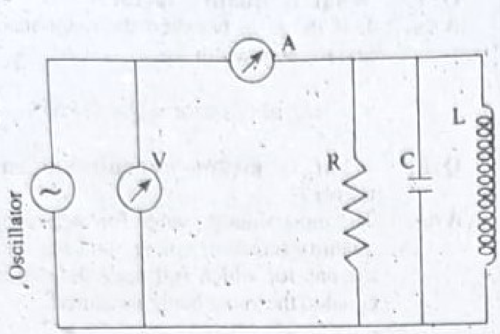
No. of Obs.	1	2	3	4	5	6	7	8	9
Frequency KHz	2.0	2.5	3.0	3.5	3.8	4.5	5.0	6.0	8.0
Current mA	0.2	0.31	0.57	1.65	3.33	0.89	0.55	0.33	0.21

Practical no.2:

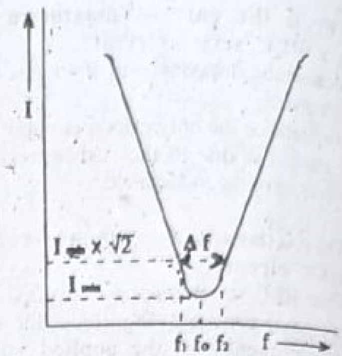
"To study the behavior of RLC Parallel circuit and determination of its resonance frequency"

Expt. No.38. To study the characteristics of RLC parallel (rejector) circuit.

Apparatus. Audio oscillator, resistor (27K , 0.25W), capacitor (0.01 µf), inductance (110 mH or any available value), multimeters with AC current and voltage ranges.



(a)



(b)

Observations and calculations :

Value of inductance used $= L = \dots$ henry

Value of capacitance used $= C = \dots$ farad

Value of resistance used $= R = \dots$ ohm

Resonance frequency calculated from above values $= f_o = \frac{1}{2\pi\sqrt{LC}} = \dots$ hertz

Oscillator output voltage $= \dots$ volt

Sr. No.	1	2	3	4	5	6	7	8	9	10	11	12
Frequency Hz												
Current mA												

Results from graph :

1. Resonance frequency $= f_o = \dots$ Hz
2. Lower limit frequency $= f_1 = \dots$ Hz
3. Upper limit frequency $= f_2 = \dots$ Hz
4. Bandwidth $= f_2 - f_1 = \Delta f = \dots$ Hz
5. Quality factor $= Q = \frac{f_o}{\Delta f} = \dots$ Hz

Procedure :

1. Select a suitable combination of R, L and C.

   Take R in the range 25KΩ – 1MΩ
   Take L in the range 100 mH – 500 mH
   Take C in the range 0.001 μf – 0.1 μf

2. Connect the circuit as shown in figure (a).

3. Set the oscillator output to a moderate value, say, 5 volts.

4. Set the oscillator frequency equal to the calculated resonance frequency.

5. Set the multimeter current range to 10 mA , AC.

6. Switch on the oscillator and observe the current flowing in the circuit.

   If the frequency of the oscillator is exactly equal to the resonance frequency of the circuit, the current flowing should be minimum. It can be verified by slightly adjusting the oscillator frequency.

7. Bring the oscillator frequency to a value well below the resonance frequency. The current in the circuit should rise. Adjust the frequency so that a suitable current, (say 2 to 3 mA) flows in the circuit.

8. Increase the frequency in regular steps of say, 1000 Hz to a value well above the resonance frequency till the current rises to about the same value as it was with the lowest frequency. Change the frequency in smaller steps around the resonance frequency.

   For each value of frequency, note the corresponding current.

   Make sure that the output voltage of the oscillator remains constant for all the frequencies.

9. Plot current values against frequency to get a curve as shown in Fig. (b).

   In case the frequency variation is very large, the curve should be plotted between current and log of frequency.

10. Determine the bandwidth and quality factor.

Precautions and sources of error :

1 to 4. Same as in experiment No.5
5. Output voltage of the oscillator should be moderate.

Viva Voce :

Q.1. Why is a RLC parallel circuit called a rejector circuit?

Ans. A given combination of R, L and C in parallel dis-allows the current to flow in a certain frequency range only. For this reason it is known as a rejector circuit i.e. it rejects some specific frequencies.

Q.2. What is meant by resonance in RLC parallel circuit?

Ans. For a certain frequency of the sinusoidal voltage applied to the RLC parallel circuit, the current flowing in the circuit has a minimum value. This phenomenon is known as resonance.

Q.3. Why is the current minimum at resonance in a RLC parallel circuit.

Ans. Because the impedance of the circuit is maximum at resonance.

Q.4. What is meant by response curve of a RLC parallel circuit?

Ans. Same as Q.No.4, experiment No.37.

Q.5. What are lower and upper limit frequencies?

Ans. In a RLC parallel circuit, the current is minimum at resonance frequency. At all other frequencies the current has a higher value. The frequencies f_1 and f_2, below and above the resonance frequency at which the current rises to $\sqrt{2}$ or 1.414 times of its minimum value are known as lower and upper limit frequencies respectively, Fig. (b).

Q.6. What is bandwidth of RLC parallel circuit?

Ans. Same as Q.No.6, experiment No.37.

Q.7. What is quality factor?

Ans. Same as Q.No.7, experiment No.37.

Specimen set of observations :

R = 27K , C = 0.01 μf , L = 110 mH.

Output of oscillator fixed at 5.0 volts.

Calculated resonance frequency = 4830 Hz

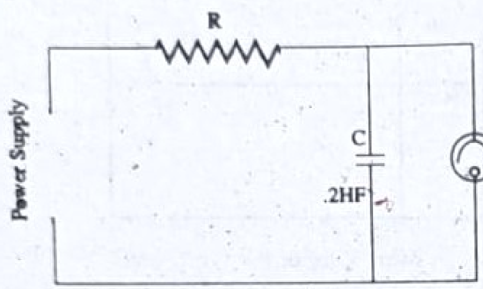
Resonance frequency from graph = 4700 Hz

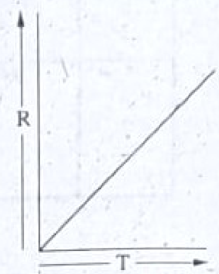
Sr. No	1	2	3	4	5	6	7	8	9	10
Frequency KHz	2.0	3.0	4.0	4.4	4.7	5.0	6.0	7.0	7.6	8.0
Current mA	2.35	1.15	0.5	0.3	0.25	0.3	0.85	1.55	2.15	2.5

Practical no.3:
"To determine the high resistance by Neon flash lamp and a capacitor"

Expt. No.25(b). To determine the high resistance by neon flash lamp and a capacitor.

Apparatus. Power supply (250 V), neon lamp, capacitor (.2μF), known resistances of the order of mega ohm, (1, 2, 3, 4, 5, 6 M ohms) unknown high resistance and stop watch.





Observations and Calculations.

Determination of time period with known resistance.

Sr. No.	Known Resistance R	Time for 20 flashes			Time period $T = t/20$
		t_1	t_2	$t = \frac{t_1 + t_2}{2}$	
	MΩ	sec	sec	sec	sec

Determination of time period with known resistance.

Unknown resistance X	Time for 20 flashes			Time period $T' = t'/20$
	t'_1	t'_2	$t' = \frac{t'_1 + t'_2}{2}$	
MΩ	sec	sec	sec	sec

Value of unknown resistance X from the graph = ... MΩ

Procedure:

1. Sketch the circuit diagram.

2. Connect the neon flash lamp to the D.C. supply through a high resistance R and a known capacitance C as shown in the circuit diagram.

3. Switch on the power supply (of constant voltage) and record the average time of 20 flashes. Workout time period T of the flash.

4. Repeat the experiment with at least five more known high resistances calculating time period for the flash in each case.

5. Plot a graph between R and T as shown.

6. Now insert the given unknown resistance X in place of R and determine time period for the flash as before.

7. From the graph read off the value of resistance against the time period T'. This value of resistance is equal to the unknown resistance X.

Sources of error and precautions:

1. The power supply used should be arranged to give constant voltage.
2. The voltage supplied from the D.C. source should exceed the striking voltage for the neon lamp.
3. The resistances should be of the order of mega ohms to get measurable time period of the flash.

Viva Voce:

Same as in experiment No. 25(a).