EXPERIMENT-4

LCR RESONANCE

AIM : To study the resonance effect when the components of LCR circuit are in series connection.

APPARATUS :

1.) Oscillator (1 to 1Mhz)
2.) Resistors
3.) Capacitors
4.) Inductors
5.) AC milli-ammeter
6.) Voltage meter

OBSERVATIONS :

- Connect the resistor, capacitor and inductor in series and connect a voltage meter across resistor to find ac voltage.
- The oscillator is used to change the frequency.

1.) 1st set of values

- **Resistor (R) = 47 ohm**
- **Capacitance (C) = 100nF**
- **Inductance (L) = 2mH**
- **Inductive Resistance (LR) = 0.8 ohm**

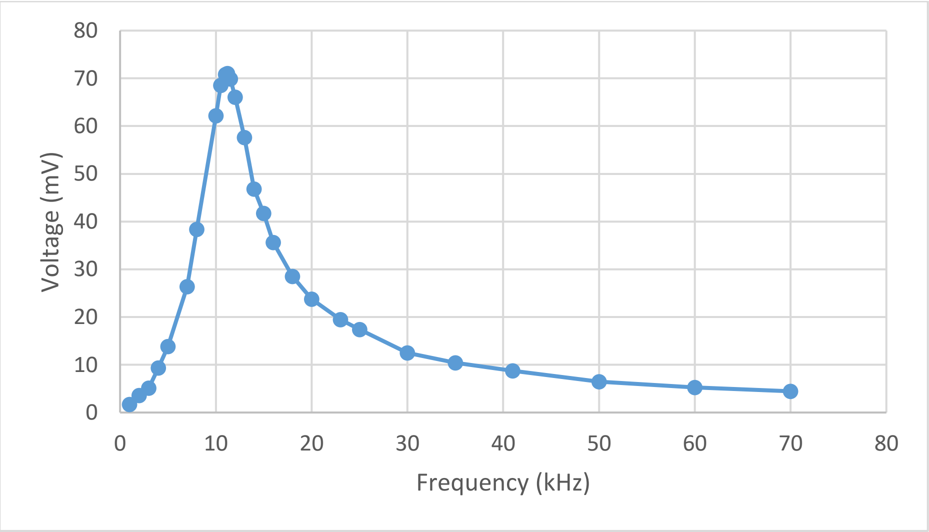
➔ Changing the frequency of the input and gauging the voltage across the resistor, we find the peak where resonance occurs.

➔ Following is the table of varying voltage with different frequencies :

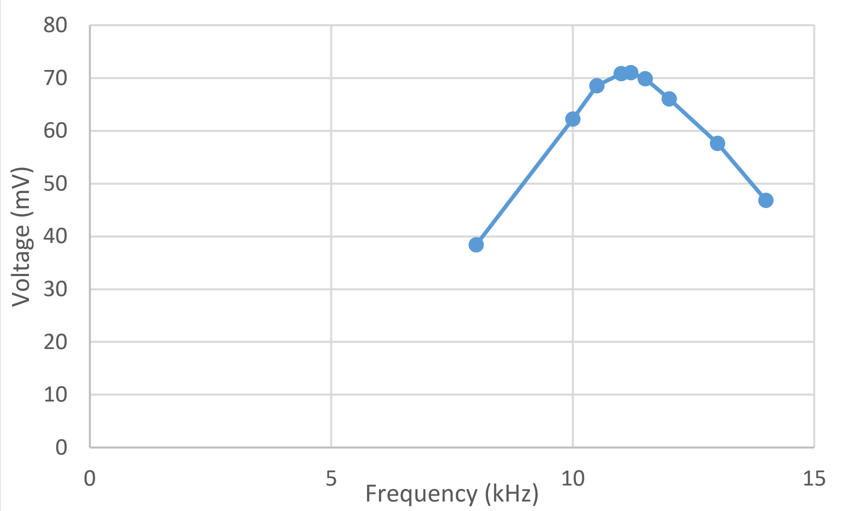
Frequency (kHz)	*Voltage across Resistor (mV)*
1	1.7
2	3.57
3	5.14
4	9.35
5	13.85
7	26.39

8	38.4
10	62.2
10.5	68.53
11	70.84
11.2	71.02
11.5	69.87
12	66.05
13	57.64
14	46.83
15	41.75
16	35.65
18	28.52
20	23.75
23	19.45
25	17.38
30	12.47
35	10.45
41	8.76
50	6.49
60	5.28
70	4.44

➔ Graph:



➔ Zooming in the resonance region :



- From prior knowledge we know that at resonance the reactance is zero and thus all the supplied voltages goes to the resistor and is the maximum value of the resistor.
- From the graph we can know that the maximum value of voltage is attained at **11.2kHz** at the maximum voltage is **71.01mV**.
- Theoretically if we find the value of frequency (f) : $f = 1/2\pi\sqrt{LC}$ which comes out to approximately equal to 11.2kHz which matches the experimental value attained from the graph.
- Also **, ɣ=R/L =23500**, for frequency 23500/2π = **3.74 kHz** .
  Therefore the **Q-factor** = Natural frequency / ɣ = **3.**
  Now (Max. power /2) ≈ V(max)/ √2 = **50.22 mV**
  Now theoretically Natural frequency ±ɣ/2 =(9.45 and 13.19)
  At **9.45kHz** and **13.19kHz** the value of voltage across the resistor is almost equal to **50 V**
- Therefore from the graph we can find the maximum power /2 and also the quality factor of the circuit.

2.) 2nd set of values :

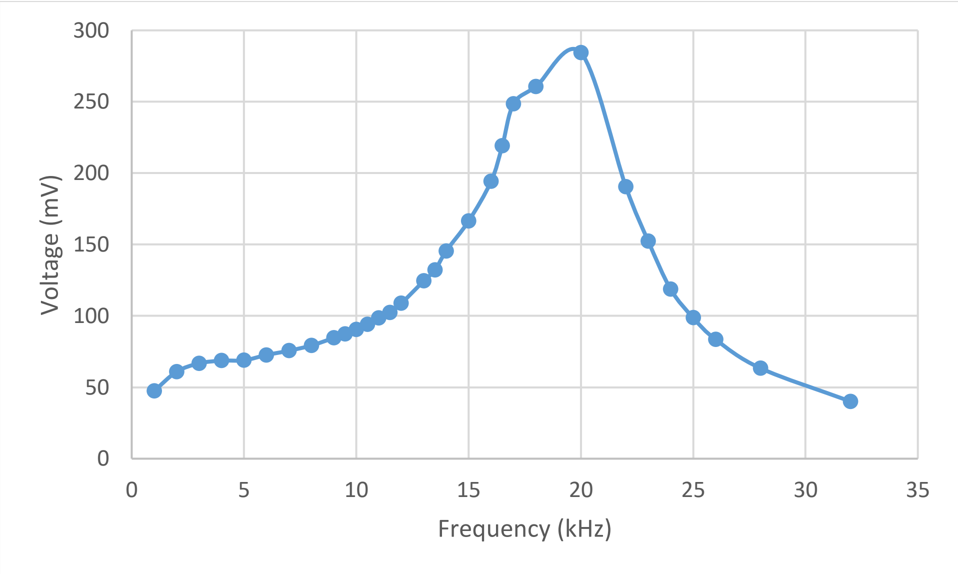
- **Resistor (R) = 1000 ohm**
- **Capacitance (C) = 100nF**
- **Inductance (L) = 2mH**
- **Inductive Resistance (LR) = 0.8 ohm**

➔ Following is the table of varying voltage with different frequencies :

Frequency (kHz)	*Voltage (mV)*
1	47.5
2	60.89
3	66.75
4	68.66
5	68.91
6	72.64

7	75.61
8	79.28
9	84.58
9.5	87.28
10	90.46
10.5	94.12
11	98.49
11.5	102.25
12	108.74
13	124.44
13.5	132.07
14	145.45
15	166.43
16	194.2
16.5	219.2
17	248.5
18	260.7
20	284.3
22	190.45
23	152.24
24	118.6
25	98.67
26	83.45
28	63.32
32	40.13

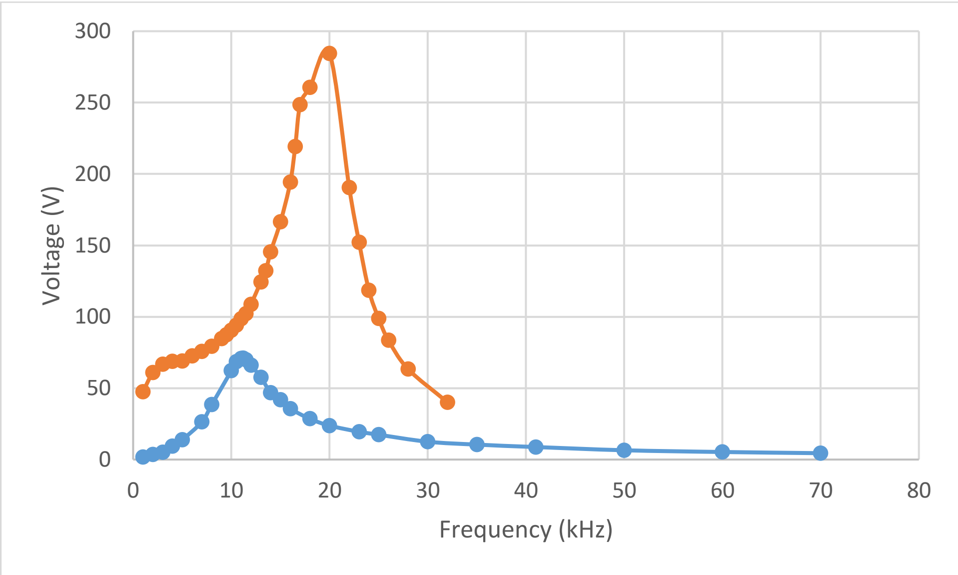
➔ Graph for the table :



- Here the maximum value of voltage is **284.3 mV** which is attained at the frequency of **20khz** that can be interpreted from the graph.
- While the theoretical value is 11.2kHz which is very less than the obtained practical value.

- One of the reason of this shift in the peak value is the high value of resistance itself has some capacitance which changes the natural resonance frequency of the system.

➔ Plotting the values together :



- Here we can see that the graph approaches the peak when the circuit is in resonance and reactance tends to be zero.

CONCLUSION :

- The value of **Impedance (Z)** = $\sqrt{\left(wL - \frac{1}{wC}\right)^2 + R^2}$, so for the impedance to be minimum $wL = 1/wC$, therefore $w = 1/\sqrt{LC}$ gives the least impedance and maximum voltage to the resistor and thus the power which we also found experimentally.
- Also due to high resistance (R) the damping in the system increases and the graph becomes non-peaky.