AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

408/1, Kuratoli, Khilkhet, Dhaka 1229, Bangladesh

Assignment Title:	Analysis of RC, RL, RLC series circuits and verification of KVL in RLC series Circuit.		
Assignment No:	08	Date of Submission:	November 27, 2022
Course Title:	Introduction to Electrical Circuits Laboratory		
Course Code:	COE2102	Section:	T
Semester:	FALL 2022-23	Course Teacher:	BISHWAJIT BANIK PATHIK

Declaration and Statement of Authorship:

1. I/we hold a copy of this Assignment/Case-Study, which can be produced if the original is lost/damaged.
2. This Assignment/Case-Study is my/our original work and no part of it has been copied from any other student's work or from any other source except where due acknowledgement is made.
3. No part of this Assignment/Case-Study has been written for me/us by any other person except where such collaboration has been authorized by the concerned teacher and is clearly acknowledged in the assignment.
4. I/we have not previously submitted or currently submitting this work for any other course/unit.
5. This work may be reproduced, communicated, compared and archived for the purpose of detecting plagiarism.
6. I/we give permission for a copy of my/our marked work to be retained by the Faculty for review and comparison, including review by external examiners.
7. I/we understand that Plagiarism is the presentation of the work, idea or creation of another person as though it is your own. It is a formofcheatingandisaveryseriousacademicoffencethatmayleadtoexpulsionfromtheUniversity. Plagiarized material can be drawn from, and presented in, written, graphic and visual form, including electronic data, and oral presentations. Plagiarism occurs when the origin of them arterial used is not appropriately cited.
8. I/we also understand that enabling plagiarism is the act of assisting or allowing another person to plagiarize or to copy my/our work.

* *Student(s) must complete all details except the faculty use part.*
** Please submit all assignments to your course teacher or the office of the concerned teacher.

Group Name/No.: 8 / Ground

No	Name	ID	Program	Signature
1	MAHNAZ TABASSUM ORPITA	22-46024-1	B. Sc. in CSE	Orpita
2	LIDA KHAN MUKTI	22-47000-1	B. Sc. in CSE	Lida
3	TARIN SULTANA	22-47045-1	B. Sc. in CSE	Tarin
4	A. F. M. RAFIUL HASSAN	22-47048-1	B. Sc. in CSE	Rafiul

Faculty use only		
FACULTYCOMMENTS	Marks Obtained	8
	Total Marks	

Abstract:

The experiment was conducted to develop an unstanding of circuits containing R, L and C components. It was also to be able analyze the outputs of RL and RC circuits. The objectivesof this experiment was RC, RL and RLC series circuit to find the phase relationship between V and I in an RLC series circuit practically with simulated or theoritical results.
In this experiment some basic tools like oscilloscope, function generator, resistor, inductor, capacitor, connecting were are used. After completing the experiment, we are able to draw the complete vector diagram of an RLC sereis circuit and able to verify KVL through this experiment.

Theory:

RC Series Circuit: A resistory capacitor circuit (RC circuit), or RC network, is an electric circuit composed of resistors and capacitor in series driven by a voltage or current source (see the figure-1). A first order RC circuit is composed of one capacitor and its simplest type of RC circuit.

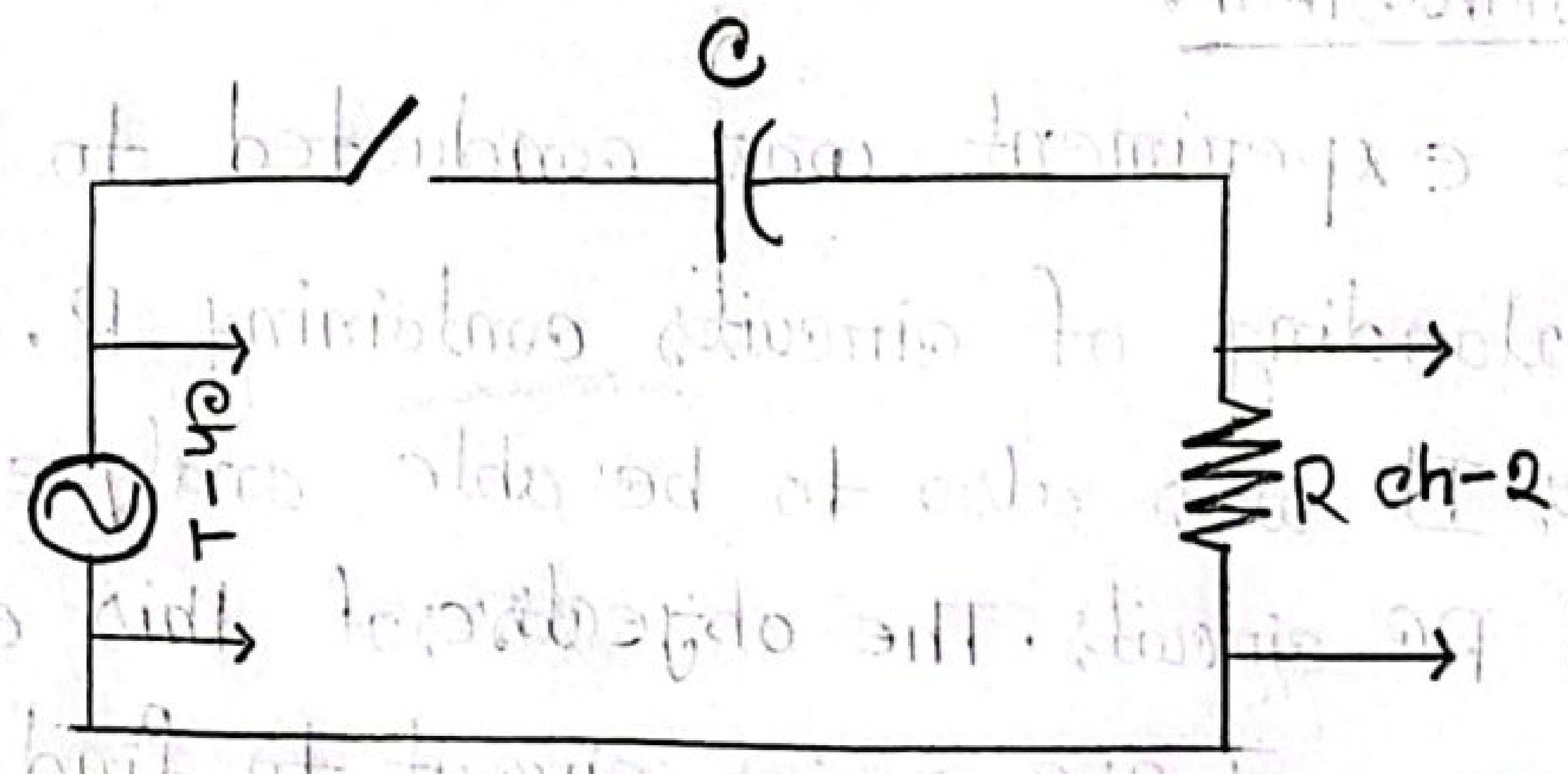


Figure -1

Analysis of a Series Circuit: For doing a complete analysis of a series RC circuit, given the value of R, C and V_T.

Step 1. Calculate the value of X_C:

$$X_C = 1/(2\pi f C)$$

Step 2. Calculate the total impedance Z:

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

Step 3. Use Ohm's Law to calculate the total current I_T:

$$I_T = V_T / Z$$

Differences between Rectangular & Polar representation of Impedence:

• In Rectangular form:

$$Z_{RC} = R - jX_C$$

• In Polar form:

$$Z_{RC} = \sqrt{R^2 + X_C^2} \angle \tan^{-1}\left(\frac{X_C}{R}\right)$$

Impact of frequency on the value of capacitance:

Figure 1·1 will shows the impact of frequency by varying the value of Capacitance in series resonance.

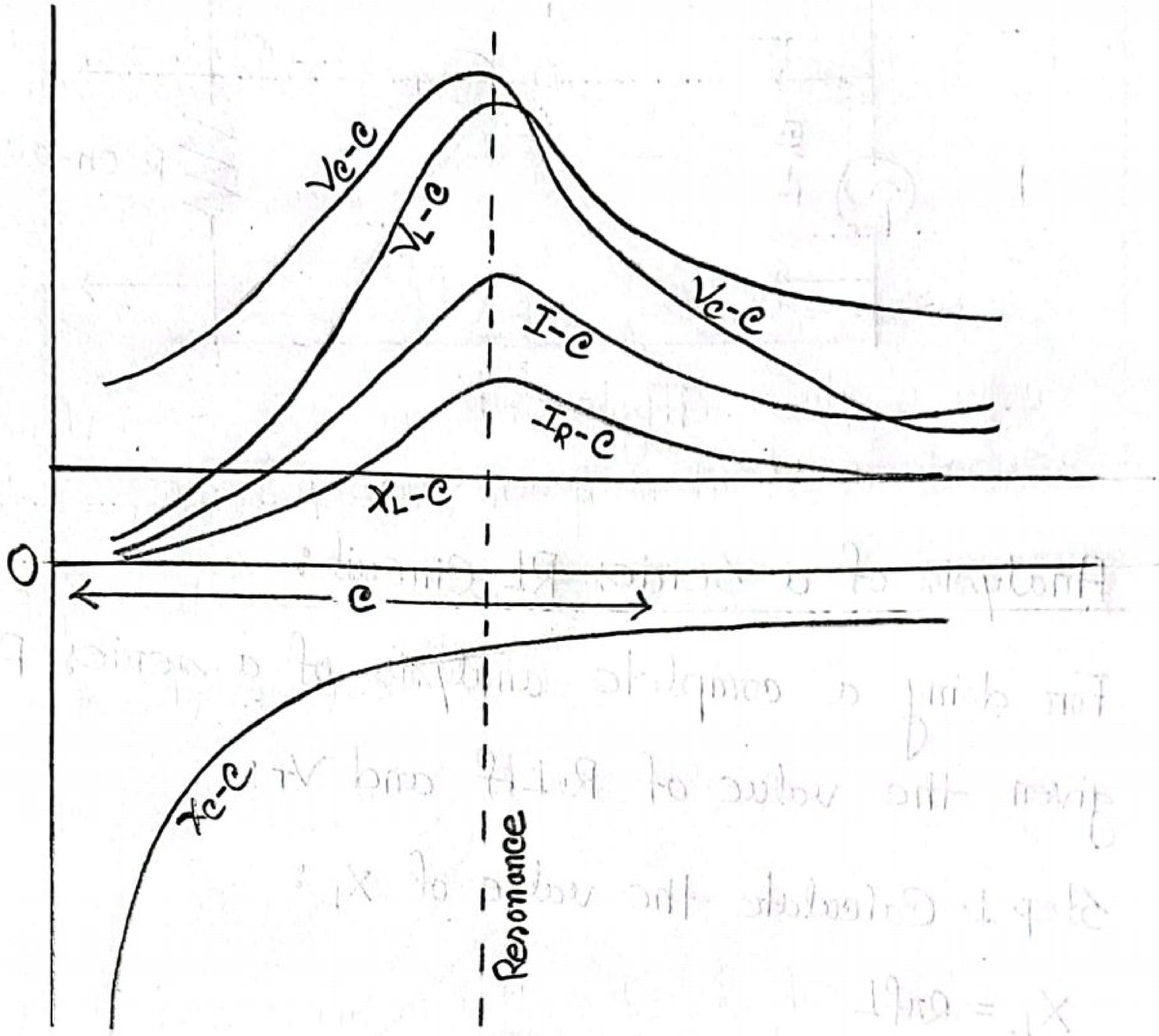


Figure-1·1

RL Series Circuit:

A resistor-inductor circuit (RL circuit), or RL networks, is an electric circuit composed of resistors and inductor is in series driven by a voltage or current source (see the figure-2). A first order RL circuit is composed of one resistor and one inductor and is the simplest type of RL circuit.

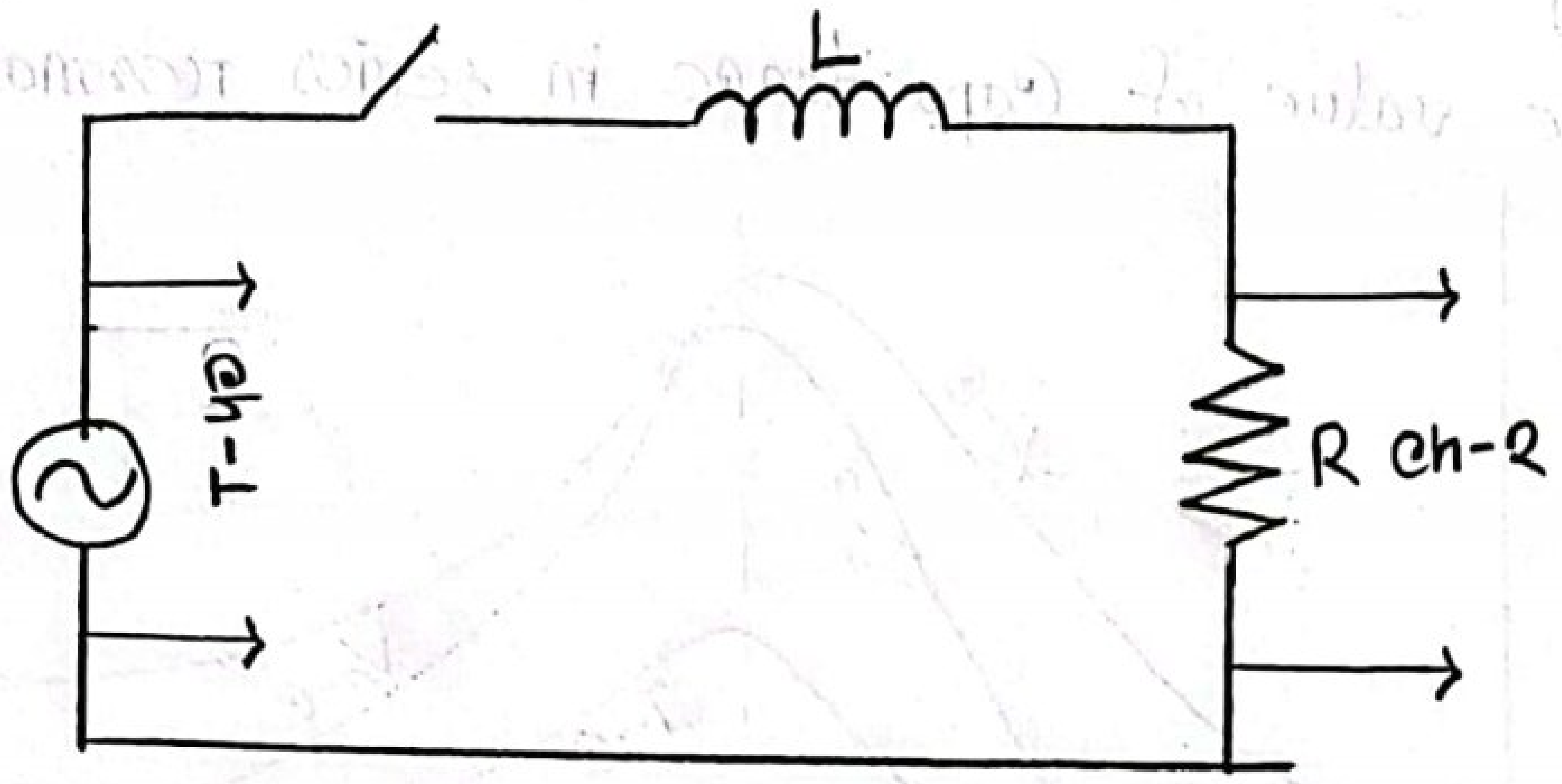


Figure-2

Analysis of a Series RL Circuit:

For doing a complete analysis of a series RL circuit, given the value of R, L, f and V_T.

Step 1. Calculate the value of X_L:

$$X_L = 2\pi f L$$

Step 2. Calculate the total impedence:

$$Z_{RL} = \sqrt{(X_L^2 + R^2)}$$

Step 3. Use Ohm's Law to calculate the total current I_T:

$$I_T = \frac{V_T}{Z}$$

Differences between Rectangular & Polar representation of Impedence:

- In Rectangular form:

$$Z_{RL} = R + j\,(X_L - X_C)$$

- In Polar form:

$$Z_{RL} = \sqrt{R^2 + (X_L - X_C)^2}\ \angle \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$

Impact of frequency on the value of inductance:

Figure 2.1 will shows the Impact of frequency by varying the value of Inductance in series resonance.

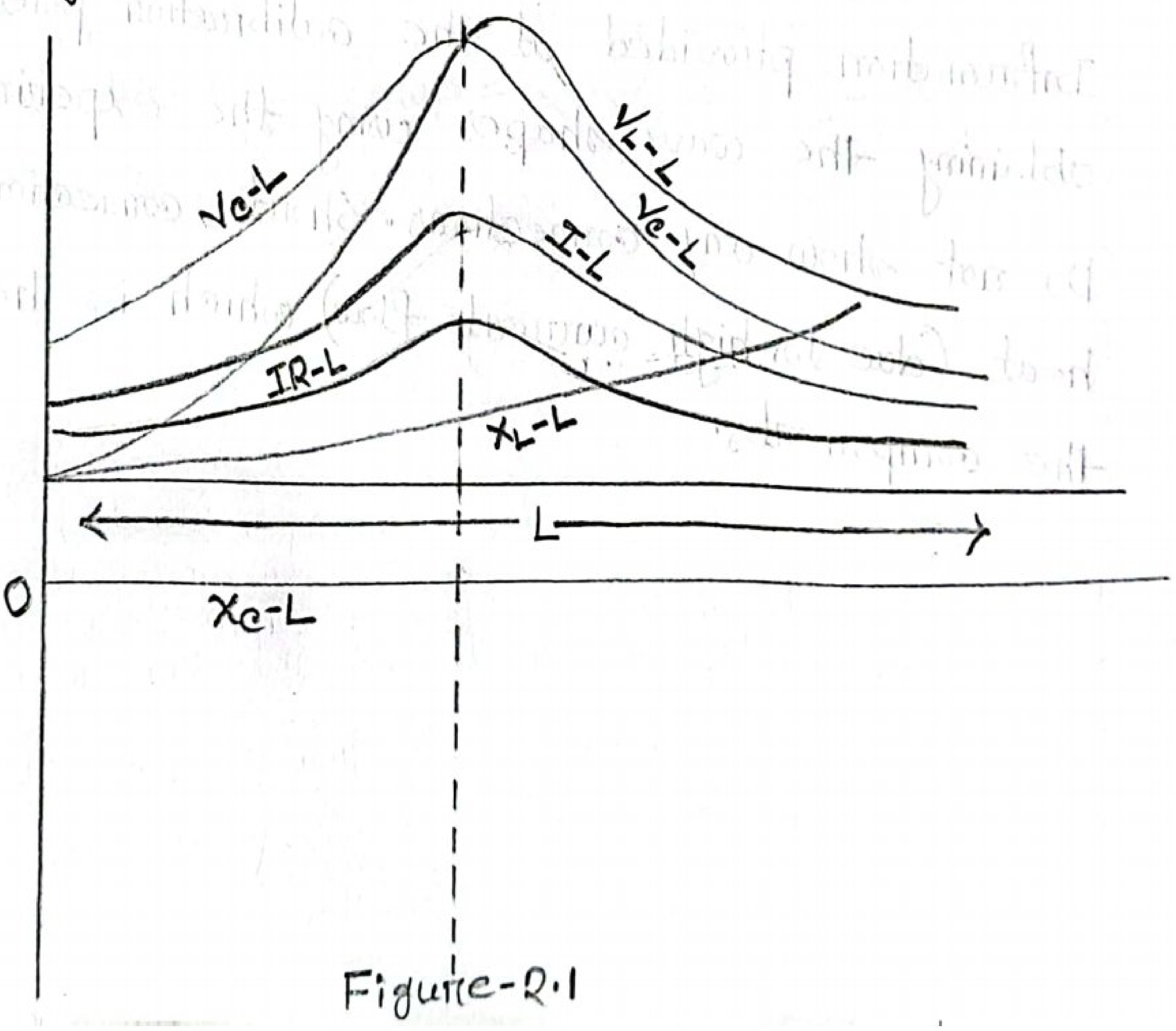


Figure-2.1

Apartus:

1. Oscilloscope
2. Function generator
3. Resistor
4. Inductor
5. Capacitor
6. Connecting war
7. Bred Board

Precautions:

Oscilloscope should be properly calibrated using the Information provided at the calibration port before obtaining the wave shapes using the experimental set up. Do not show any connections. Short connection can produce heat (due to high current flow) which is harmful for the components.

Revelant Equation:

Inductive reactance, $X_L = 2\pi f L$

Capacative reactance, $X_C = \frac{1}{2\pi f C}$

Net reactance, $X = X_L - X_C$

Total impedence, $Z = \sqrt{R^2 + X^2}$

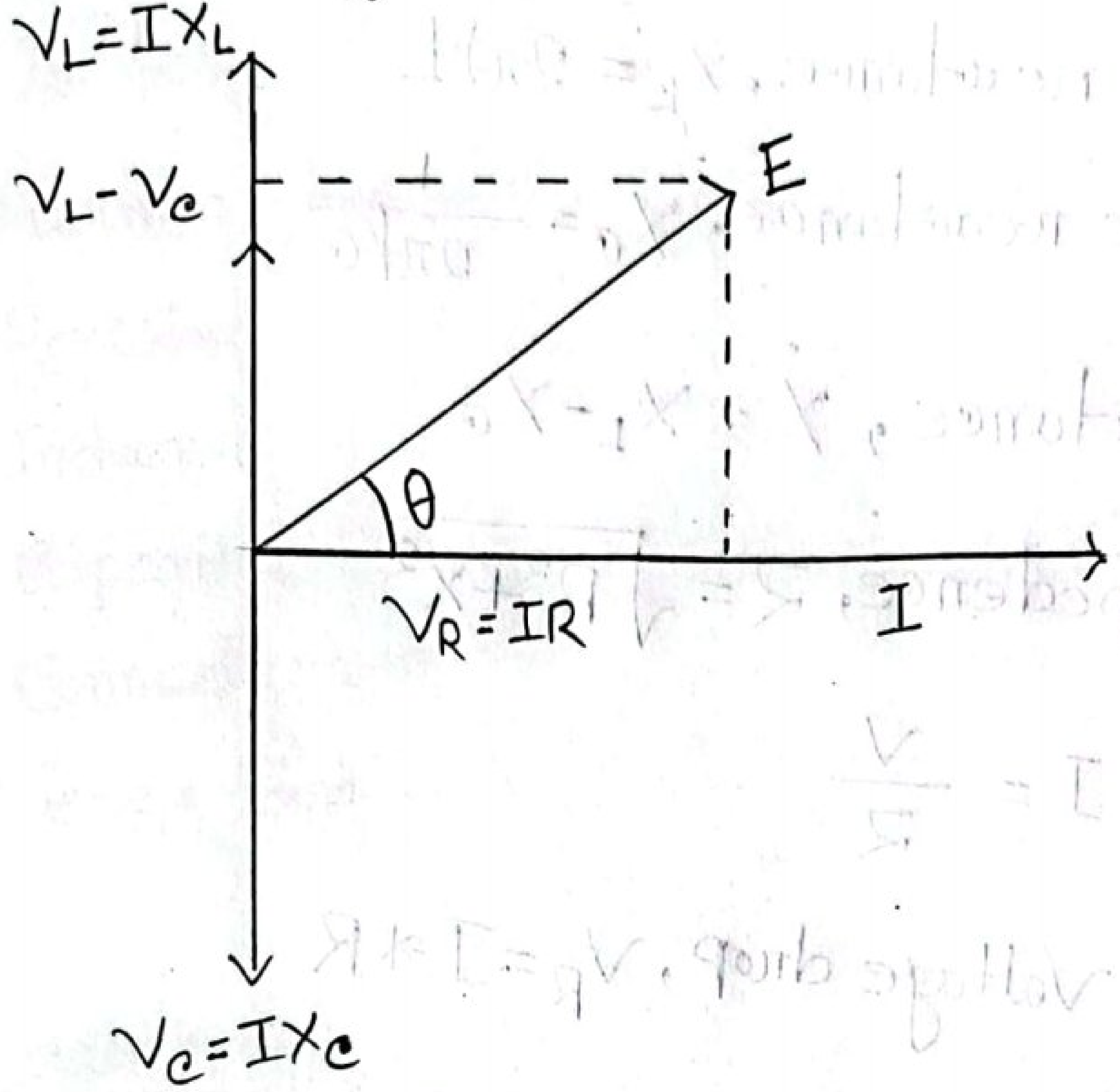
Current, $I = \frac{V}{Z}$

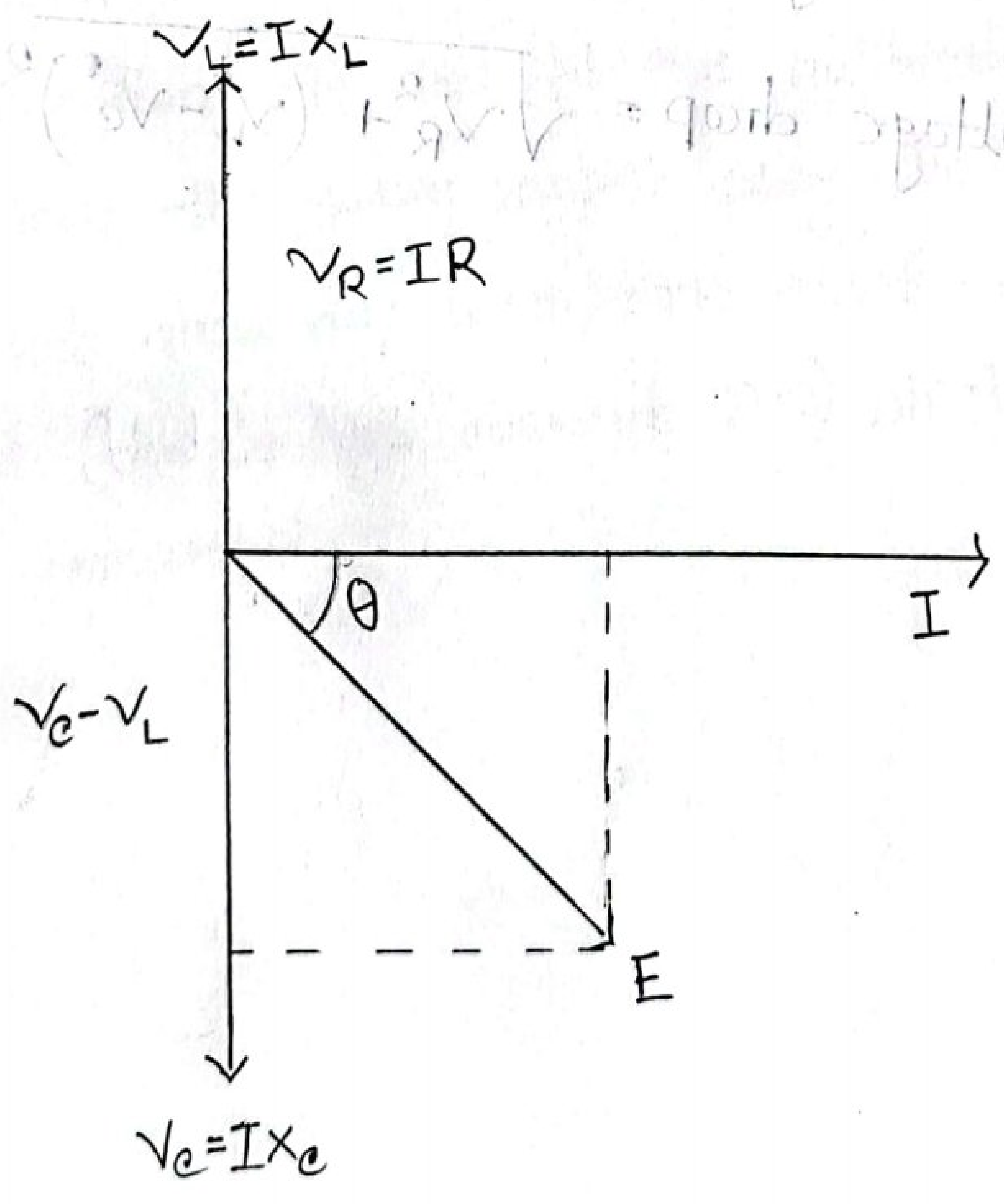
Resistive Voltage drop, $V_R = I * R$

Reactive Voltage drop, $= V_L - V_C$

Total Voltage drop $= \sqrt{V_R^2 + (V_L - V_C)^2}$

Vector Diagram:





Experimental Data:

Table-01: For RC Series Circuit

f (KHz)	E (V)	V_R (V)	I (A)	R (Ω)	X_C (Ω)	Z rectangular (Ω)	Z polar (Ω)	V_C (V)
5 KHz	0.255	0.1914	3.42×10^{-4}	560	31.831	560+j31.831	$560.8\angle 3.25^{\circ}$	0.01088
20 KHz	0.169	0.155	2.768×10^{-4}	560	7.96	560+j7.96	$560.1\angle 0.81^{\circ}$	2.203×10^{-3}

Table-02: For RL Series Circuit

f (KHz)	E (V)	V_R (V)	I (A)	R (Ω)	X_L (Ω)	Z rectangular (Ω)	Z polar (Ω)	V_L (V)
5 KHz	0.255	0.1060	1.893×10^{-4}	560	628.32	560+j628.32	$841.6\angle 48.29^{\circ}$	0.119
20 KHz	0.19	0.0388	6.93×10^{-5}	560	2513.28	560+j2513.28	$2556.51\angle 77.44^{\circ}$	0.174

For RLC Series Circuit:

1. Constract the circuit as shown in the figure-3. Connect channel-1 of the oscilloscope accross the ac voltage source and channel-2 of the oscilloscope across R.
2. Set amplitude of input signal.
3. Set the frequency of the signal generator.
4. Measure value of I.
5. Measure value of V_R, V_L, V_C
6. Verify KVL using the experimental data.
7. Complete the following table.

f KHz	E (V)	V_R (V)	I (A)	X_L (Ω)	V_L (V)	X_C (Ω)	V_C (Ω)	θ	$V=\sqrt{V_R^2+(V_L^2-V_C^2)}$ (V)

Table : 3 for RLC series Circuit

Result and Calculation :

RC Circuit :

When frequency = 5 KHz

$$X_C = \frac{1}{2\pi f c} = \frac{1}{2\times 3.1416\times 5\times 10^3\times 10^{-6}}$$

$$= 31.831\,\Omega$$

$$Z = 560 + j\,31.831\,\Omega$$

$$V_R = 0.1914\,V$$

$$I = \frac{V_R}{R} = \frac{0.1914}{560} = 3.42\times 10^{-4}\,A$$

$$V_C = I\times X_C = 0.01088\ V$$

When frequency = 20KHz,

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\times 3.1416\times 20\times 10^{3}\times 10^{-6}}$$

$$= 7.968\,\Omega$$

$Z = 560 + j7.96\,\Omega$

$V_R = 0.155V$

$$I = \frac{V_R}{R} = \frac{0.155}{560} = 2.768\times 10^{-4}\,A$$

$V_C = I X_C$

$$= 2.768\times 10^{-4}\times 7.96 = 2.203\times 10^{-3}\,\cancel{A}\,V$$

R-L Circuits:

When frequency = 5 KHz

$X_L = 2\pi f L$

$= 2\times 3.1416\times 5\times 10^{3}\times 20\times 10^{-3}\,H$

$= 628.32\,\Omega$

$Z = 560 + j628.32\,\Omega$

$V_R = 0.1060V$ ~~= 0.1060V~~

$$I = \frac{V_R}{R} = \frac{0.1060}{560} = 1.893\times 10^{-4}\,A$$

$V_L = IX_L = 1.893\times 10^{-4}\times 628.32 = 0.119\,V$

When frequency = 20 KHz.

$X_L = 2\pi f L = 2 \times 3.1416 \times 20 \times 10^3 \times 20 \times 10^{-3}$

$= 2513.28 \Omega$

$Z = 560 + j\,2513.28 \Omega$

$V_R = 0.0388 V$ $\cancel{= 0.0388 V}$

$I = \frac{V_R}{R} = \frac{0.0388}{560}$

$= 6.93 \times 10^{-5}$

$V_L = I X_L = 6.93 \times 10^{-5} \times 2513.28 = 0.174 V$

Result:

for R-C circuit,

When $f = 5$ KHz,

$V_C + V_R = 0.20 V$

$V_P = 0.25 V$

When $f = 20$ KHz,

$V_C + V_R = 0.157 V$

$V_P = 0.169 V$

For R-L Circuit,

When $f = 5\,KHz$

$$V_L + V_R = 0.225\,V$$

$$V_P = 0.255\,V$$

When $f = 20\,KHz$

$$V_L + V_R = 0.218\,V$$

$$V_P = 0.199\,V$$

$$\sqrt{V_L^2 + V_R^2} = V_s$$

So, $V_L + V_R \approx V_P$

$$V_L + V_R \approx V_P$$

So, the KVL is verified.

Discussion:

1. The oscilloscope was checked before the start of the experiment
2. Function generator was checked also.
3. The magnitudes of were taken carefully.
4. Every data was measured carefully.
5. All the data was placed in data table carefully.
6. After the calculation by using the given equation a result was obtained.

Conclusion:

The purpose of the experiment was to a understanding of circuits containing R, L and C components. Conducting the experiment the objects we find RC, RL and RLC series circuits. After the experiment we are able to understand the phase relationship between V and I in an RLC ~~circuit~~ series circuit. We also learn by conducting this experiment to draw the complete vector diagram of an RLC circuit. And also verify KVL through the experiment.

References:

i) "Fundamental of "Electric Circuit" by Alekzendre Sadiku
ii) "Alternating Current Circuit" by George F Corcoran.