Index

Date 15/01/2025

Expt. No. 1 Page No. 1

EXPERIMENT NO. 1

* **Name:-** 3-Voltmeter method

* **Objective:-** (1) To measure the power and the power factor of a single phase load by 3-voltmeter method.

(2) To draw phasor diagram.

* **Apparatus:-**

S. No.	Equipment/ Meter	Specification	Quantity
1.	AC Voltmeter	0-300V	03
2.	Rheostat	500Ω, 1.8A	01
3.	Choke coil	4 Henry	01
4.	Single phase autotransformer	0-240V	01
5.	Connecting wires	1.5mm	As required
6.	Ammeter	0-1-03 Amp	01

* **Theory:-**

The single phase load under consideration is a choke coil. In this method, a known resistance is connected in series with the choke, and a.c. voltage is applied to the combination. The voltage across the choke (V_L), resistance (V_R)

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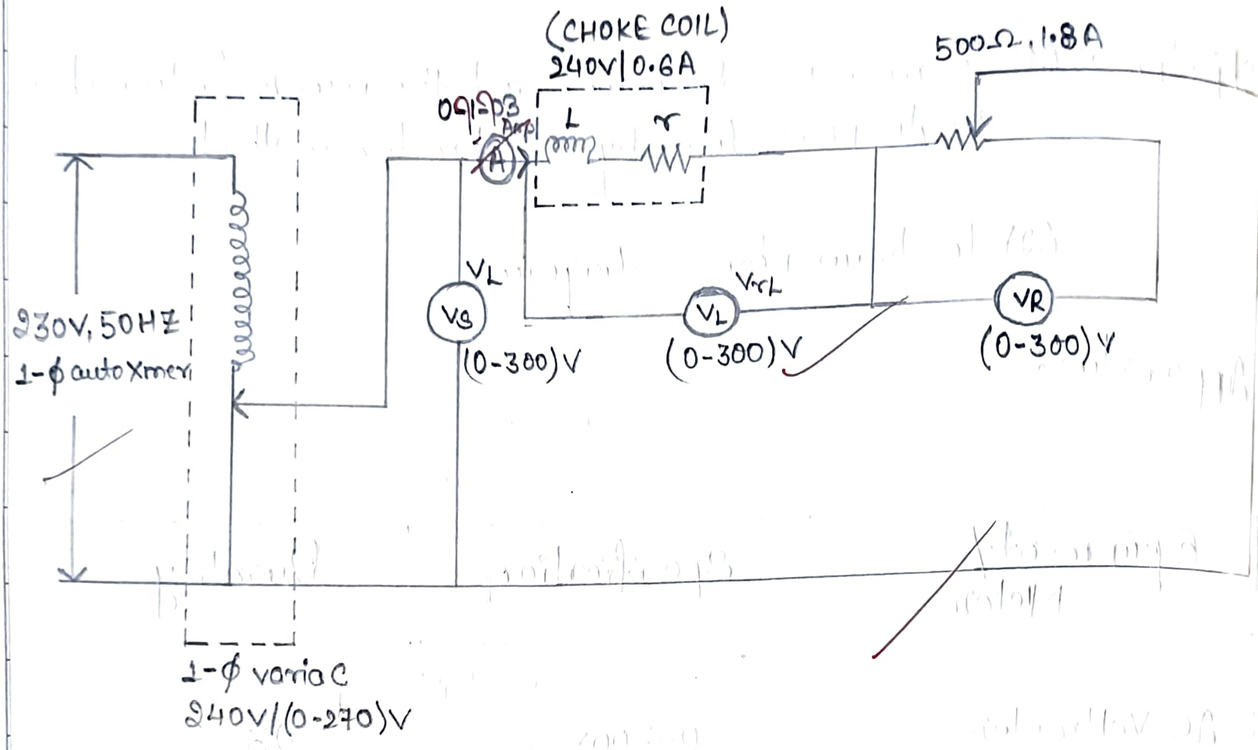
* **Circuit Diagram :-**



Date

Expt. No. 1 Page No. 2

and the supply (V_S) are measured. The voltage across the resistance gives the value of current and the vector diagram can be obtained.

$$\text{Power}(P) = \frac{V_L^2 - V_R^2 - V_{rL}^2}{2R}$$

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

$$\cos\phi = \frac{V_L^2 - V_R^2 - V_{rl}^2}{2V_{rl}V_R}$$ (ϕ is angle between V_L and V_R)

* Observation Table:-

S. No.	V_{Line} volt(v) (V_L)	I_{Line} ampere I_L (A)	V_R volt (v)	V_{Load} (V_{rL}) (v)
(1)	200	0.42	27.7	188.5
(2)	190	0.41	26.1	178.6
(3)	180	0.38	24.7	173.4
(4)	160	0.36	21.1	150.1
(5)	150	0.34	19.5	140.8
(6)	130	0.31	16.8	121.6

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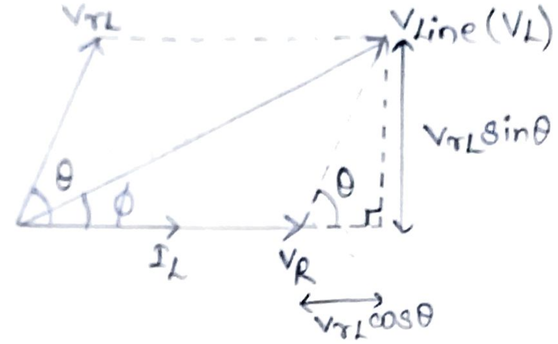
***Calculation:-**



For $V_L = 200V$,

$$\Rightarrow V_{Line}^2 = V_R^2 + V_{rL}^2 + 2V_R V_{rL}\cos\theta$$

$$\Rightarrow 200^2 = (27.7)^2 + (188.5)^2 + 2\times 27.7\times 188.5\times\cos\theta$$

$$\Rightarrow 40000 = 767.29 + 35532.25 + 10442.9\cos\theta$$

$$\Rightarrow \cos\theta = \frac{3700.46}{10442.9} = 0.35$$

$\therefore$ Power of choke coil $= V_{rL} I_L \cos\theta$

$= 188.5\times 0.42\times 0.35$

$= 27.7095W$

$$\Rightarrow \cos\phi = \frac{V_R + V_{rL}\cos\theta}{V_{Line}}$$

$$= \frac{27.7 + 188.5\times 0.35}{200}$$

$$= \frac{27.7 + 65.975}{200} = 0.468$$

$\therefore$ Power of circuit $= V_L I_L \cos\phi$

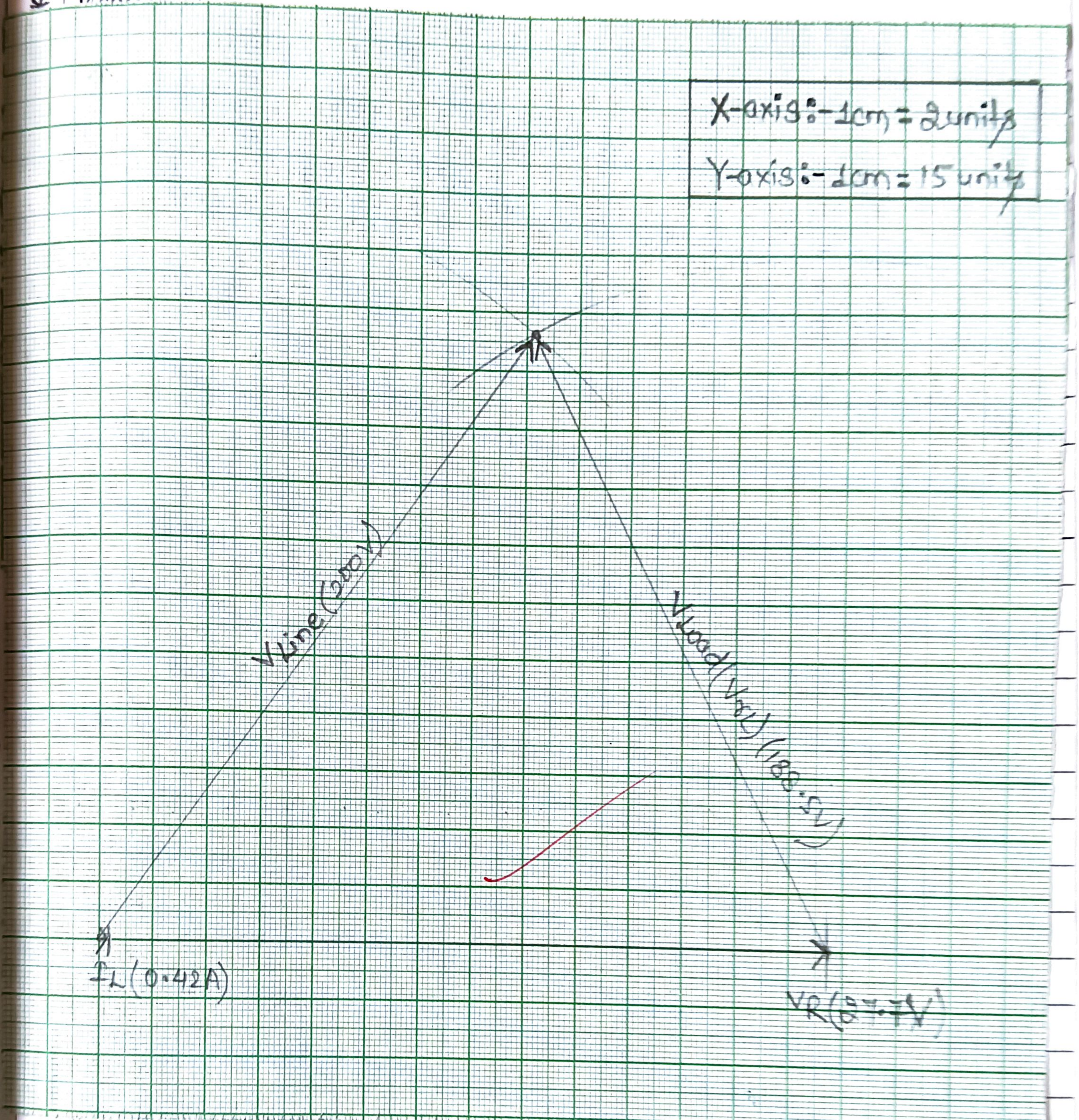
$= 200\times 0.42\times 0.468$

$= 39.34W$

Date

Expt. No. 1

Page No. 3



22/1/25

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Result :-

Power of choke coil = 27.7095 W
Power factor = $\cos\phi$ = 0.468
and, Power of circuit = 39.34 W

Precautions :-

i) Connection should be checked properly to ensure no short circuits or incorrect readings occur.

ii) Properly rated instruments must be used to prevent damage or inaccurate readings.

iii) Overloading should be avoided to ensure the safety of the circuit and measuring instruments.

iv) A stable supply voltage should be maintained to avoid fluctuations that could affect measurement accuracy.

v) Insulated tools should be used to minimize the risk of electric shock.

22/1/25

EXPERIMENT NO. 2

* **Name :-** 3- Ammeter method

* **Objective :-** (1) To measure the power and the power factor of a single phase load by 3 ammeter method.

(2) To obtain the phasor diagram.

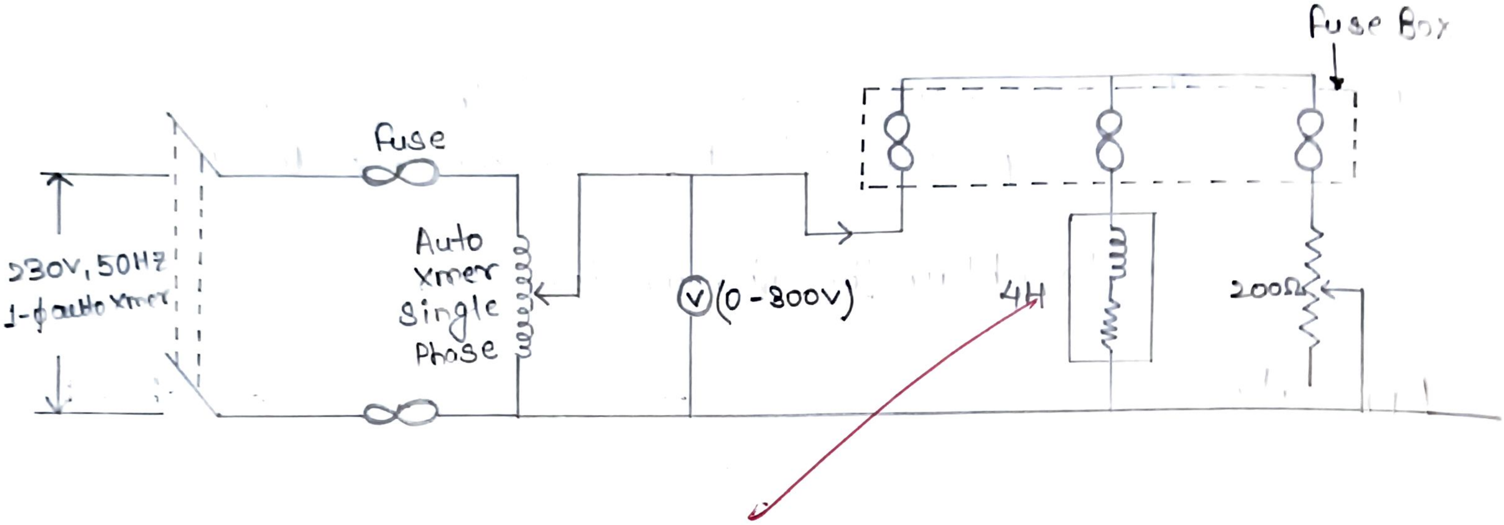
* **Apparatus :-**

S. No.	Equipment/ Meter	Specification	Quantity
(1.)	AC Ammeter	0-5A, 0-2A	1(5A), 2(2A)
(2.)	AC Voltmeter	0-150V	01
(3.)	Rheostat	500Ω, 1.8A	01
(4.)	Choke coil	4 Henry	01
(5.)	Single phase autotransformer	0-240V	01
(6.)	Connecting wires	1.5mm	As required

* **Theory :-**

A known resistance is connected in parallel to the choke and the line current in the resistance give the supply voltage. The vector diagram can be obtained and power and power factor can be calculated.

* Circuit Diagram :-



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Expt. No. 2 Page No. 5

$$\text{Power}(P) = \frac{R(I_L^2 - I_R^2 - I_{rL}^2)}{2}$$

where, R = Resistance

I_L = Line current

I_R = Resistive current / current across Resistor

I_{rL} = Current across load (Choke coil)

$$R = \frac{V}{I_R}$$

and, Power factor $\cos\phi = \frac{I_L^2 - I_R^2 - I_{rL}^2}{2 I_R I_{rL}}$

* Observation Table :-

S. No.	V_{Line} volt (V_L) (V)	I_{Line} Ampere (I_L) (A)	I_R Ampere (A)	I_{rL} Ampere (A)
(1.)	80	0.40	0.33	0.18
(2.)	100	0.51	0.44	0.21
(3.)	120	0.61	0.51	0.24
(4.)	140	0.69	0.59	0.28
(5.)	160	0.78	0.67	0.32
(6.)	180	0.91	0.76	0.37

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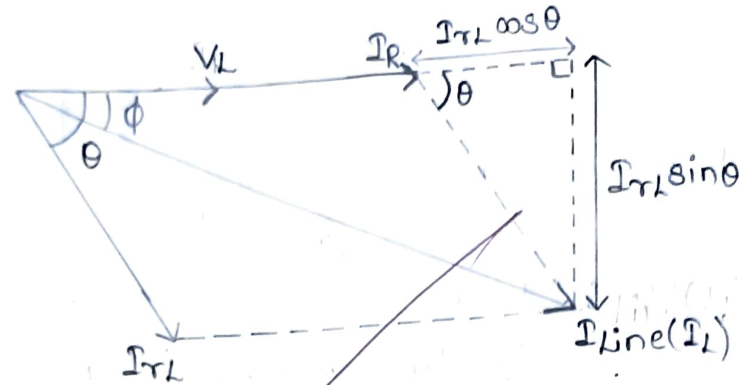
* Calculation:-



For $V_L = 180V$,

$$\Rightarrow I_{Line}^2 = I_R^2 + I_{rL}^2 + 2 I_R I_{rL} \cos\theta$$

$$\Rightarrow (0.91)^2 = (0.76)^2 + (0.37)^2 + 2 \times 0.76 \times 0.37 \times \cos\theta$$

$$\Rightarrow 0.8281 = 0.5776 + 0.1369 + 0.5624 \cos\theta$$

$$\Rightarrow \cos\theta = \frac{0.1136}{0.5624} = 0.201$$

$\therefore$ Power of choke coil $= V_L I_{rL} \cos\theta$

$$= 180 \times 0.37 \times 0.201$$

$$= 13.387\ W$$

$$\Rightarrow \cos\phi = \frac{I_R + I_{rL}\cos\theta}{I_{Line}}$$

$$= \frac{0.76 + 0.37 \times 0.201}{0.91}$$

$$= \frac{0.76 + 0.074}{0.91} = 0.916$$

$\therefore$ Power of circuit $= V_L I_L \cos\phi$

$$= 180 \times 0.91 \times 0.916$$

$$= 150.04\ W$$

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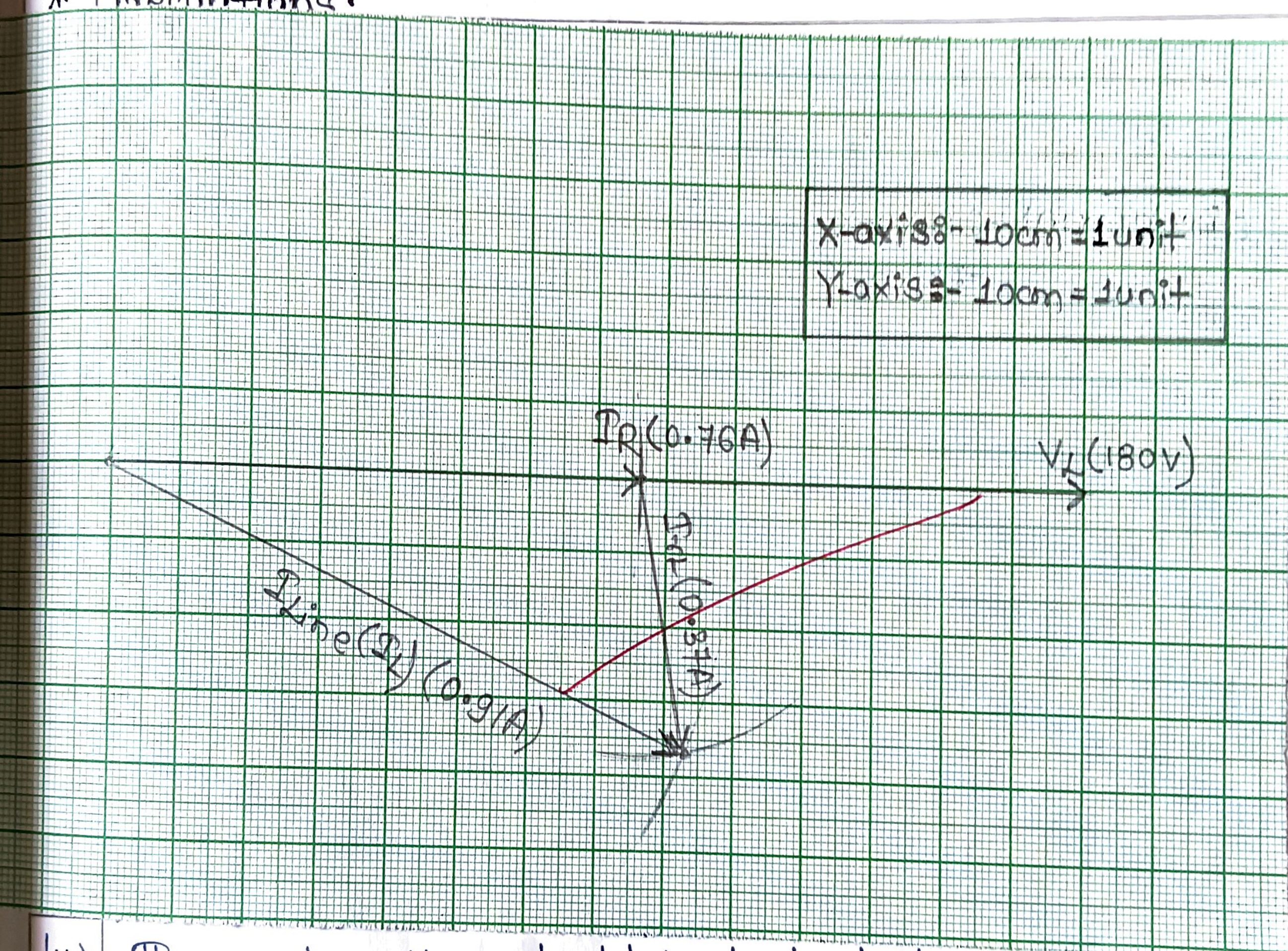
Expt. No. 2 Page No. 8

* Result:-

Power of choke coil = 13.387 W
Power factor = $\cos\phi$ = 0.916
and, Power of circuit = 150.04 W

* Precautions:-



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(v.) The supply voltage should be kept stable and constant to ensure accurate measurements of power and power factor.

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Teacher's Signature

* Result:-

Power of choke coil = 13.387W
Power factor = $\cos\phi$ = 0.916
and, Power of circuit = 150.04W

* Precautions:-

(i.) The connections of the ammeters should be checked carefully to ensure they are in the correct configuration as per the circuit diagram.

(ii.) Properly rated ammeters must be used to avoid overloading and to ensure accurate measurements.

(iii.) The circuit should be powered off while making or modifying connections to prevent electric shocks or damage to the equipment.

(iv.) The load should be maintained within the rated capacity of the circuit to avoid overheating and inaccurate readings.

(v.) The supply voltage should be kept stable and constant to ensure accurate measurements of power and power factor.

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EXPERIMENT NO. 3

* **Name:-** Study of resonance in electrical circuit.

* **Objective:-** (1) To find the condition of resonance in an AC RLC series circuit.

(2) Draw the different phasor diagrams.

* **Apparatus:-**

S. No.	Equipment/ Meter	Specification	Quantity
(1.)	Rheostat	suitable	01
(2.)	Choke coil	5H	01
(3.)	Capacitor	10μF	01
(4.)	function generator		01
(5.)	Oscilloscope		01
(6.)	Connecting wires	1.5mm	As required.

* **Theory:-**

Resonance:-

Resonance is term employed for describing the steady state operation of a circuit or system at that frequency for which resultant is in time phase with the source function despite the presence of energy storing element.

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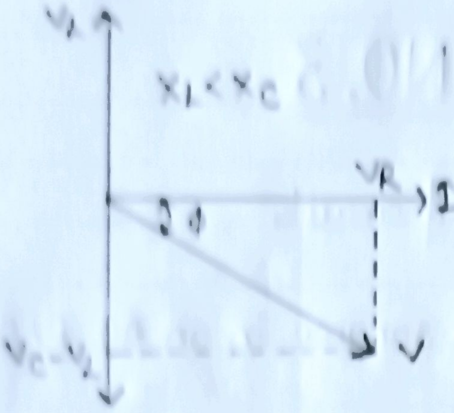

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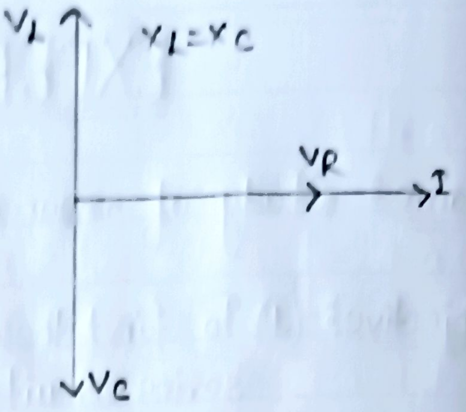
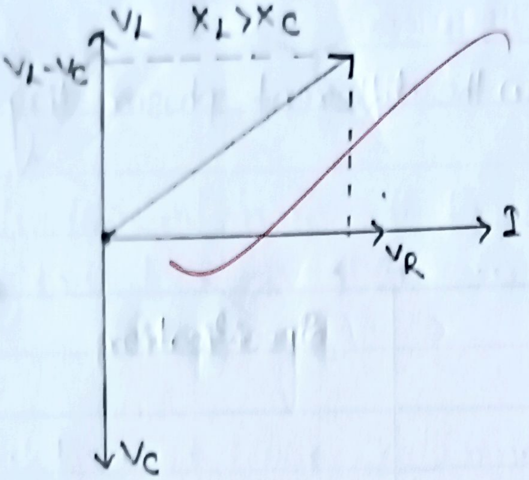
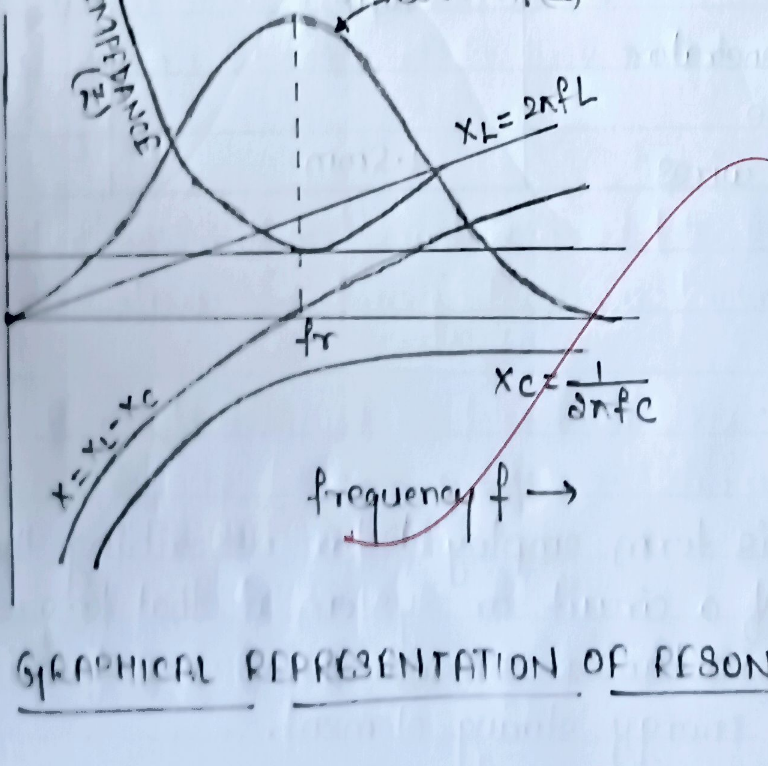






GRAPHICAL REPRESENTATION OF RESONANCE

If we have an ac circuit having a Resistance R, an inductance L and capacitance C, connected in series and apply a small voltage V but can keep the magnitude of V constant but can vary its frequency, we find that magnitude of current drawn from source of supply varies with variation in frequency. There will be a value of frequency at which the current is maximum.

Condition for Resonance :-

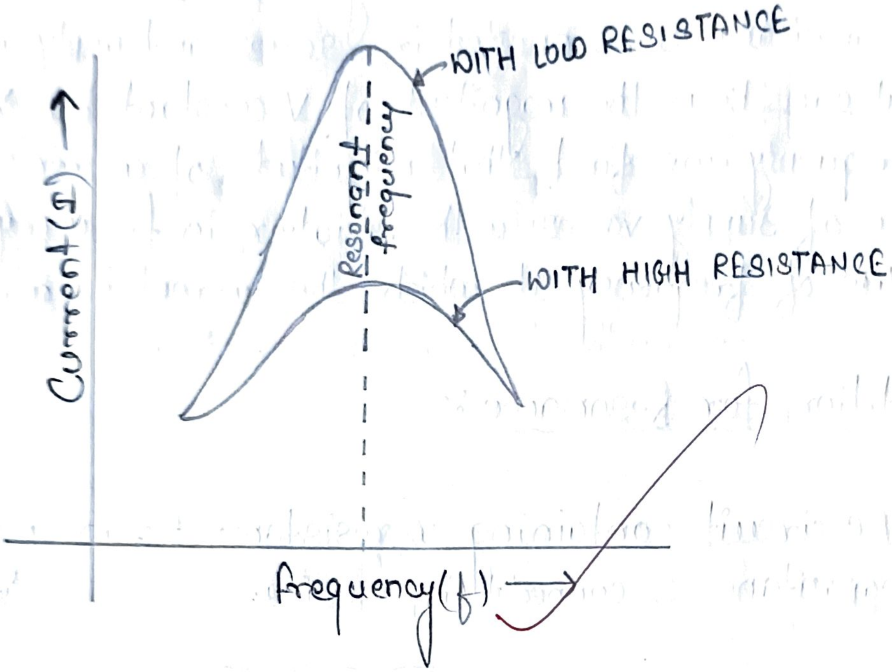
An AC circuit containing a resistance R, an inductance L and capacitance C connected in series.

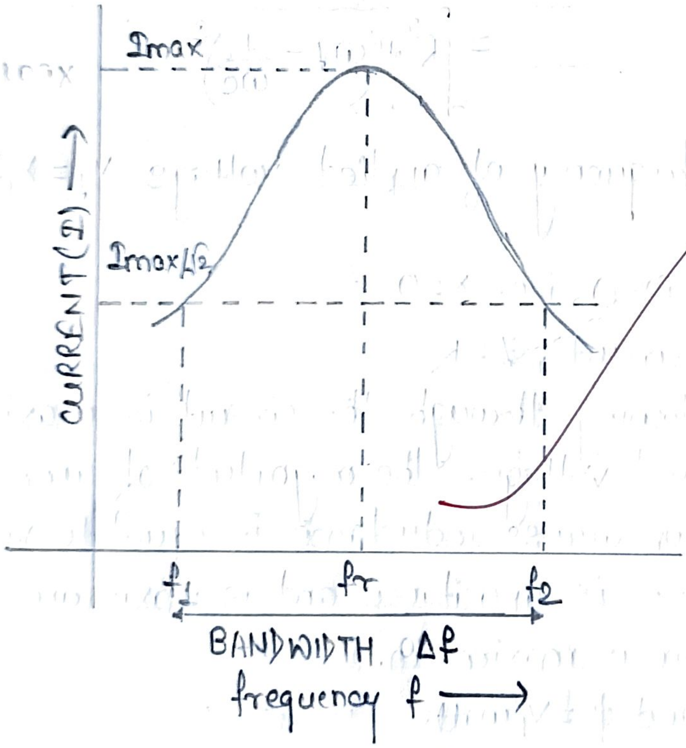
Impedance of circuit, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$$= \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

If for some frequency of applied voltage $X_L = X_C$ in magnitude then,

i) net reactance is 0, i.e. $X = 0$
ii) Impedance of circuit, $Z = R$
iii) The current flowing through the circuit is maximum and in phase with applied voltage. The magnitude of current equal to V/R.
iv) The voltage drop across inductance is equal to voltage drop across ~~inductance~~ ~~is~~ capacitance and is maximum.
v) The power factor is maximum.
vi) The power expanded $= V_1$ watts
when this condition exists; the





<u>RESONANCE CURVE</u>

$X_L = \omega_L = 2\pi f L$

$X_C = \frac{1}{2\pi f_r C} = \frac{1}{\omega C}$

$X_L = X_C \Rightarrow 2\pi f_r L = \frac{1}{2\pi f_r C} \Rightarrow f_r = \frac{1}{2\pi\sqrt{LC}}$ (Resonant frequency condition)

When an inductive reactance and a capacitive reactance are connected in parallel condition may reach under current source.

Quality factor :-

Quality factor of resonance is a dimensionless parameter that describes how underdamped an oscillator characterizes a resonator and characterizes a resonator bandwidth relative to its centre frequency.

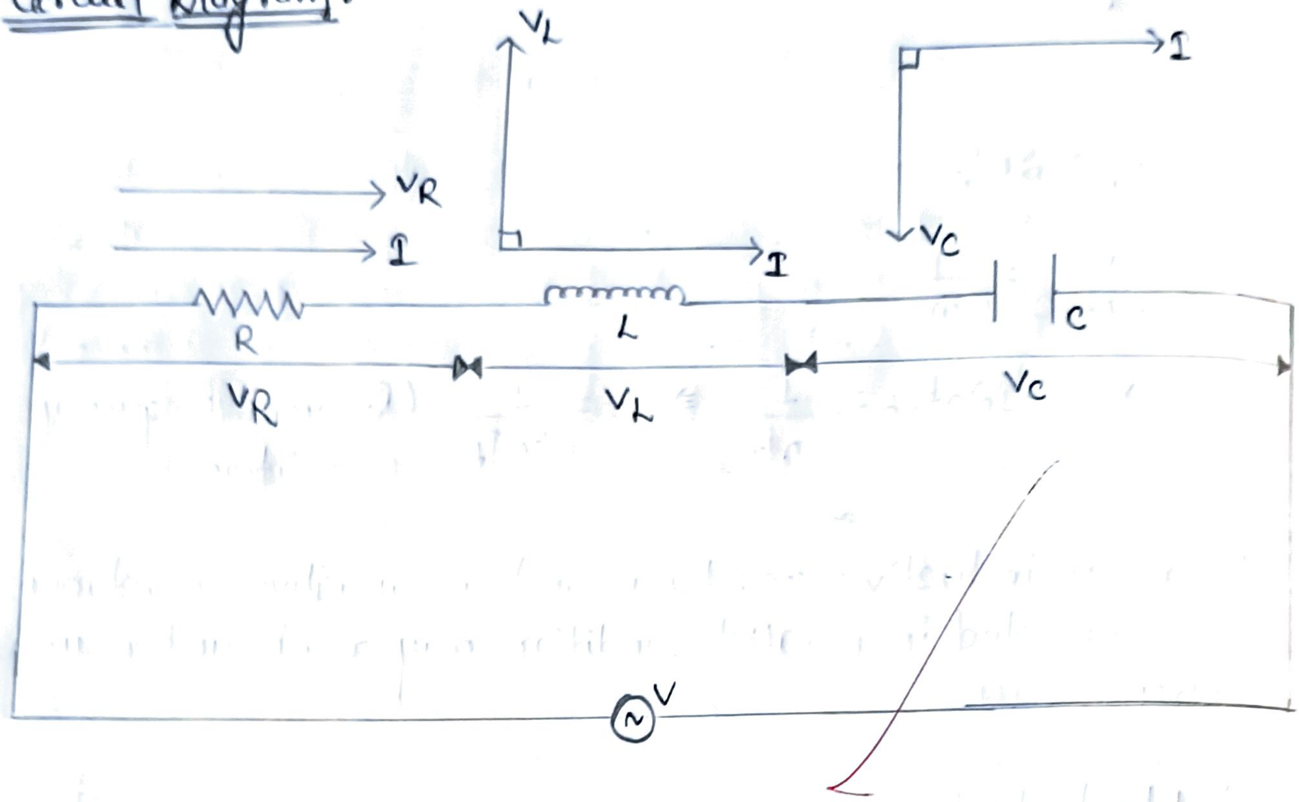
Resonant frequency :-

Resonant frequency is frequency at which a system vibrates with highest amplitude.

Selectivity :-

Selectivity of a resonant circuit is defined as ratio of resonant frequency to half the power of bandwidth.

* <u>Circuit Diagram</u> :-



Band Width :-

The total number of cycles below and above of resonant frequency for which current is equal to greater than 70.7% of resonant value is called band width.

At Resonant frequency, power factor = 1. circuit will draw maximum power.

* Result :-

The study of resonance in an AC RLC series circuit is completed successfully.

* Precautions :-

(i) The circuit connections should be checked carefully before switching on the power to avoid incorrect wiring.

(ii) Properly rated components must be used to ensure they can handle the applied voltage and current.

(iii) The frequency of the AC supply should be varied slowly to accurately observe the resonance point.

(iv) All measuring instruments should be properly calibrated to ensure accurate readings of voltage, current and freqdency.

Teacher's Signature 05/02/25

EXPERIMENT NO. 4

* **Name** :- 3-phase star connection.

* **Objective** :- (1) To obtain the relation between line and phase quantity in 3-phase star connection.

(2) To obtain the phasor diagram.

* **Apparatus** :-

S. No.	Equipment/ Meter	Specification	Quantity
(1.)	AC Ammeter	0-5A	01
(2.)	AC voltmeter	0-300V, 0-500V	01 each
(3.)	3-phase lamp load	250V, 200W	01
(4.)	3-phase autotransformer		01
(5.)	Connecting wires	1.5mm	As required

* **Theory** :-

A balanced system of 3-phase voltages had the property that their voltages are same but differing in phase from one another by 120 degree.

In a three-phase star connection, the three-phase windings are connected at a common neutral point. The line voltage is $\sqrt{3}$ times the phase voltage, while the line current equals the phase current.

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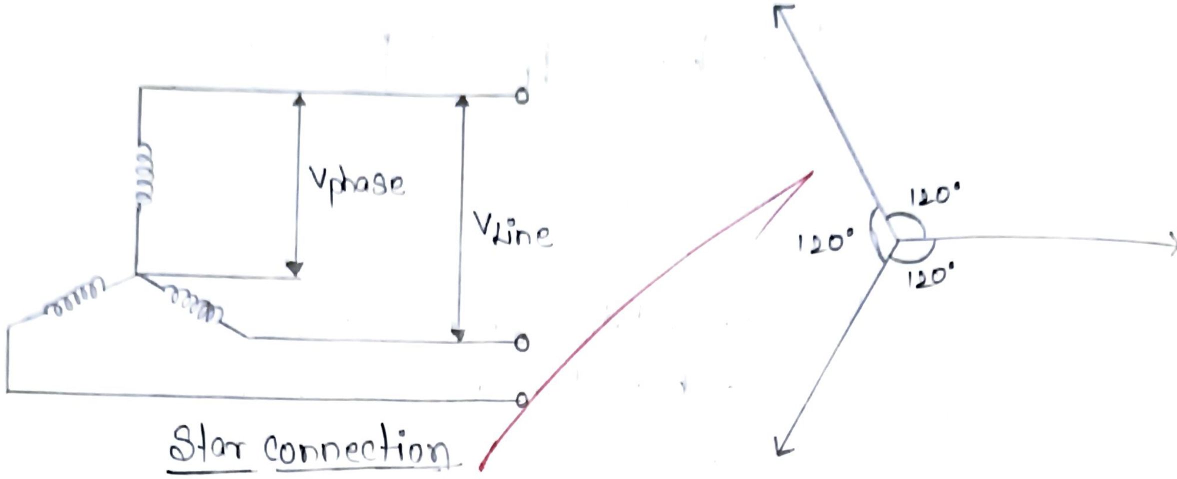
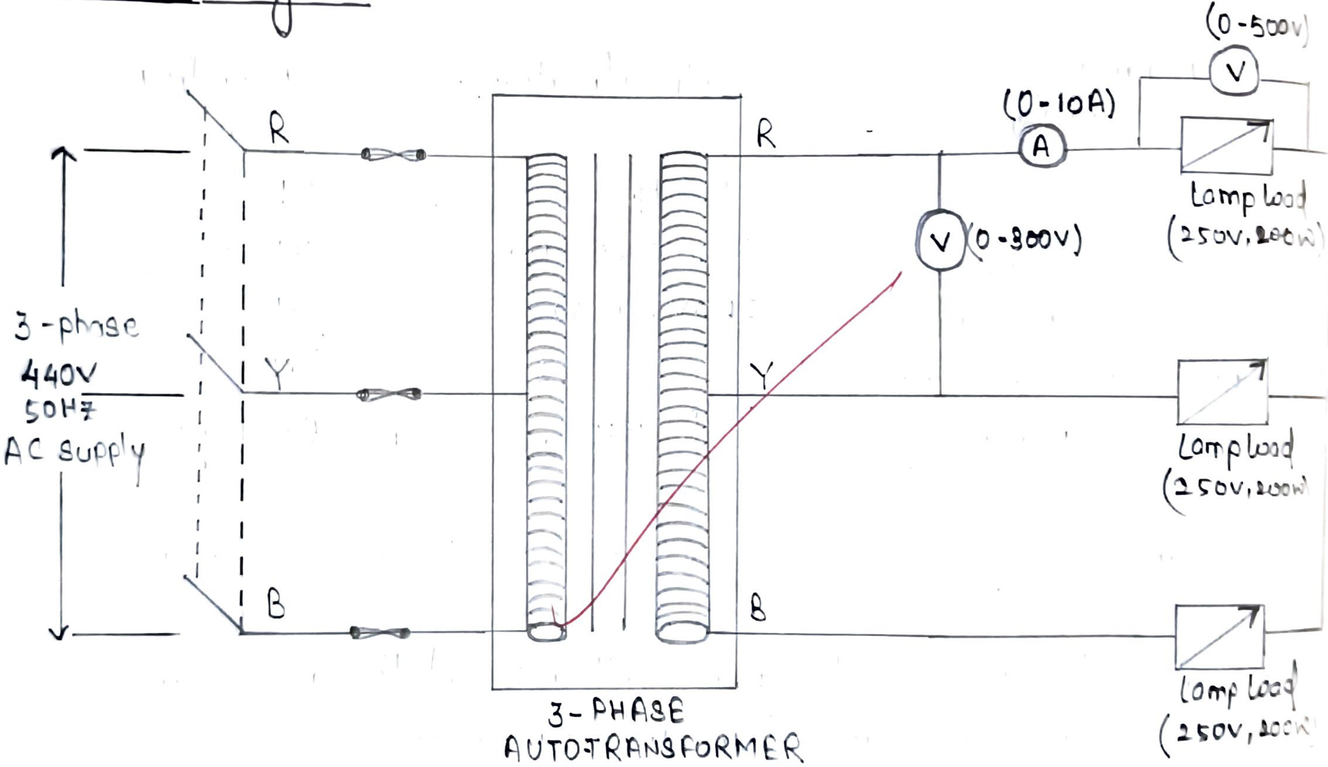


Star connection

* **Circuit Diagram:-**



In a Y connection:-

(a) Line voltage(V_L) = $\sqrt{3}$ x Phase voltage(V_{ph})

(b) Line voltages are 120 degree apart.

(c) Line voltages are 30 degree ahead of the respective phase voltages(for positive sequence).

(d) Line current(I_L) = Phase current(I_{ph})

When identical loads are connected in star in 3-phase supply the line currents and phase currents are same but the line voltages are $\sqrt{3}$ of (V_{ph}).

* **Observation Table:-**

S. No.	I Ampere (A)	Voltage across load in volts (V_{ph})	Voltage across two Line (V_L)	V_L / V_{ph}
(1.)	2.4	73	129	1.76
(2.)	2.7	76	134	1.75
(3.)	2.9	80	140	1.75
(4.)	3.1	83	145	1.74
(5.)	3.5	91	159	1.74
(6.)	3.8	97	170	1.75

Teacher's Signature

PHASOR DIAGRAM OF 3-PHASE STAR CONNECTED LOAD

$V_l = \sqrt{3} V_{ph}$

$I_l = I_{ph}$

phase voltages: V_R, V_Y, V_B

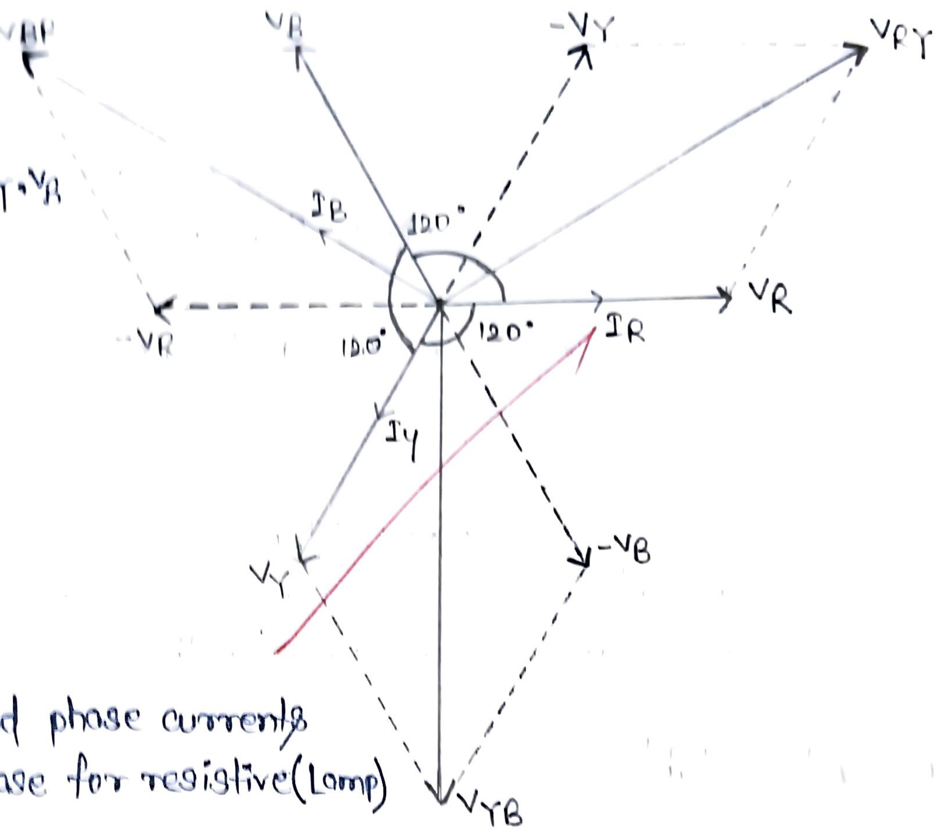
Line voltages:

V_{RY}, V_{YB}, V_{BR}.

$\vec{V}_{RY} = \vec{V}_R - \vec{V}_Y$

$\vec{V}_{YB} = \vec{V}_Y - \vec{V}_B$

$\vec{V}_{BR} = \vec{V}_B - \vec{V}_R$



Phase voltage and phase currents are in same phase for resistive (Lamp) load.

* **Calculation:-**

$\Rightarrow$ Average value $= \dfrac{1.76 + 1.75 + 1.75 + 1.74 + 1.74 + 1.75}{6}$

$= \dfrac{10.49}{6}$

$= 1.74$

$\Rightarrow$ % Error $= \dfrac{1.74 - 1.73}{1.73} \times 100$

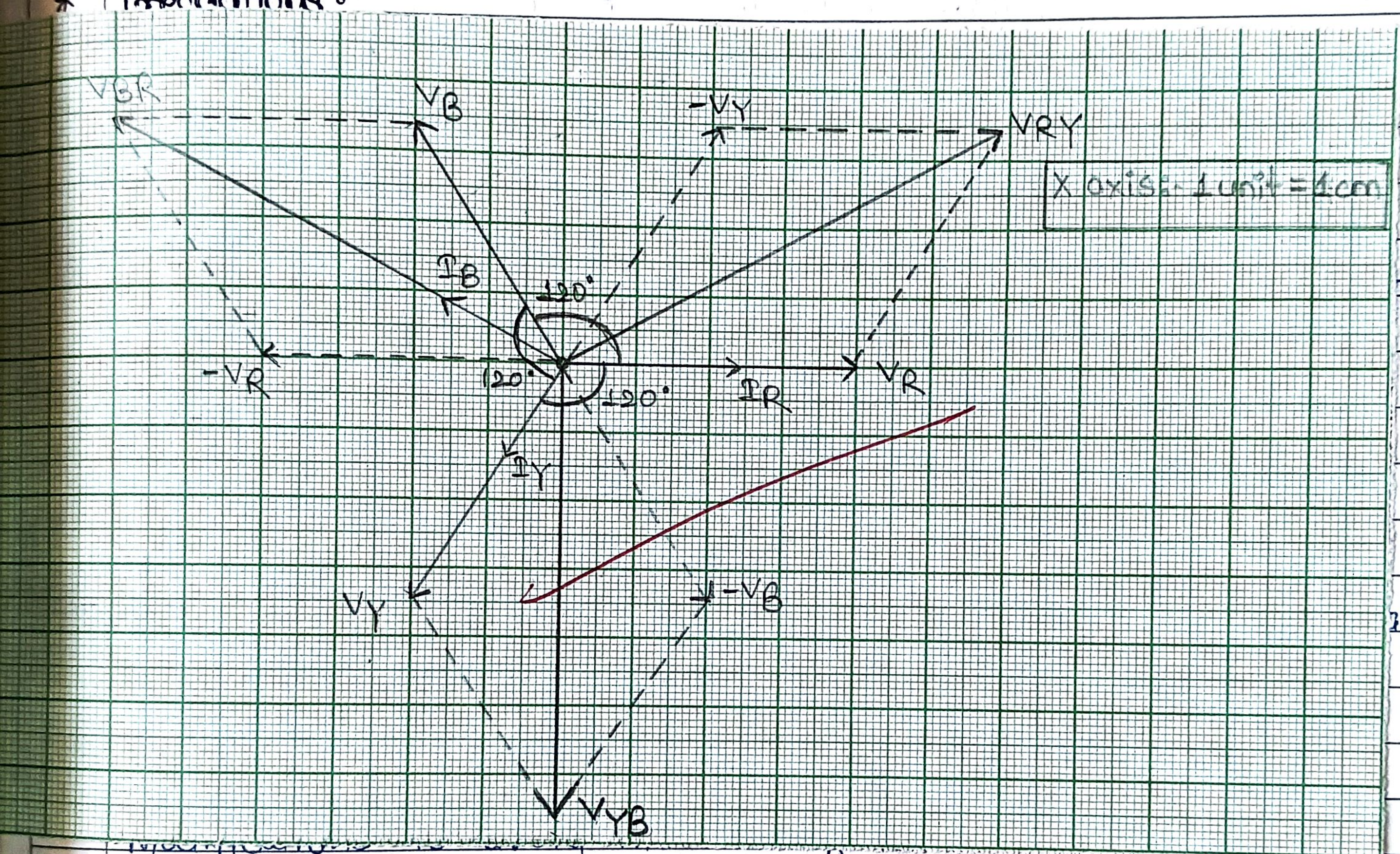
$= 0.57\%$

* Result:-

Average value of the ratio of V_L upon V_{ph} (V_L/V_{ph}) = 1.74

and, % Error = 0.57%.

* Precautions:-



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* **Result:-**

Average value of the ratio of V_L upon V_{ph} $(V_L/V_{ph}) = 1.74$

and, % Error = 0.57%.

* **Precautions:-**

(i) All circuit connections should be checked properly before switching on the power to avoid incorrect wiring.

(ii) Properly rated measuring instruments must be used to ensure accurate readings and prevent damage.

(iii) The supply voltage should be kept stable to avoid fluctuations that may affect measurements.

(iv) The neutral point should be properly grounded to ensure safety and prevent electrical hazards.

(v) The circuit should be de-energized before making any modifications to avoid the risk of electric shock.

Anjali ...
12/2/25

Date 12/02/2025

Expt. No. 5 Page No. 14

EXPERIMENT NO. 5

* **Name :-** 3-phase delta connection.

* **Objective :-** (1) To obtain the relation between line and phase quantity in 3-phase delta connection.

(2) To obtain the phasor diagram.

* **Apparatus :-**

S. No.	Equipment/ Meter	Specification	Quantity
(1.)	AC Ammeter	0-5A, 0-10A	01 each
(2.)	AC voltmeter	0-500V	01
(3.)	3-phase lamp load	250V, 200W	01
(4.)	3-phase autotransformer		01
(5.)	Connecting wires	1.5mm	As required

* **Theory :-**

A balanced system of 3-phase currents had the property that their currents are same but differing in phase from one another by 120 degree.

In a three-phase delta connection, the three-phase windings are connected end-to-end forming a closed loop. The line voltage equals the phase voltage, while the line current is $\sqrt{3}$ times the phase current.

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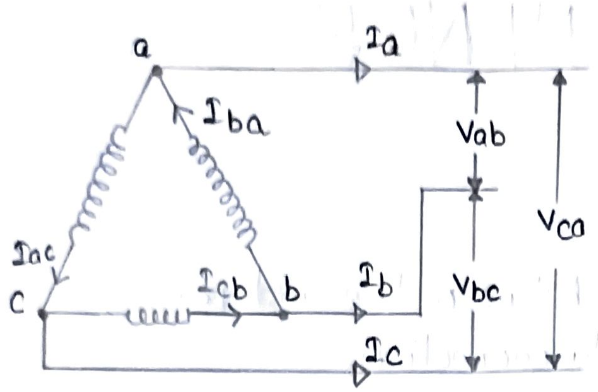
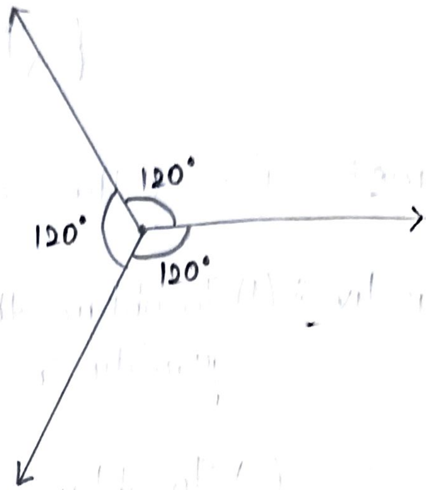
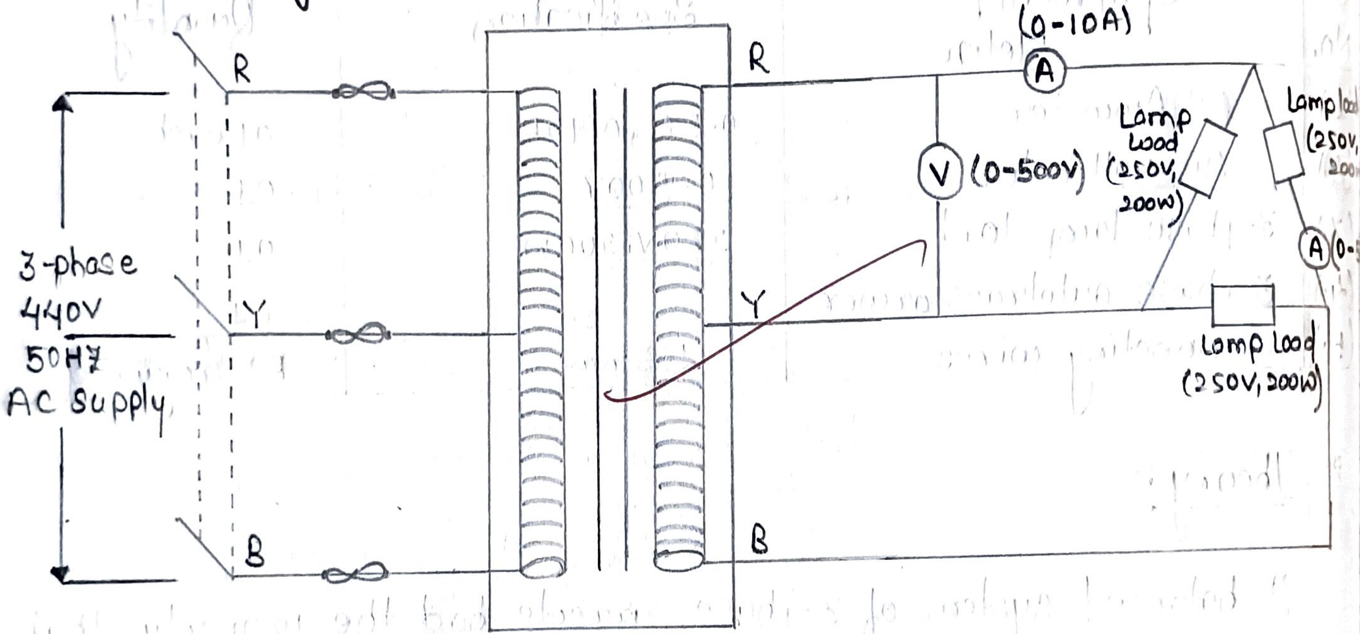


Delta connection



* Circuit Diagram :-



In a Δ connection:-

(a) Line current $(I_L) = \sqrt{3} \times$ Phase current (I_{ph}).

(b) Line currents and voltages are 120 degree part.

(c) Line currents are 30 degree ahead of the respective phase currents (for positive sequence).

(d) Line voltage (V_L) = Phase voltage (V_{ph}).
When identical loads are connected in [redacted] delta in 3-phase supply the line voltages are same but the line currents are $\sqrt{3}$ times of phase current.

* <u>Observation Table</u>:-

S. No.	V volts (V)	Current through load in ampere $(I_{ph}) \times 2$	Current through Line $(I_L) \times 2$	I_L/I_{ph}
(1.)	100	$0.64 \times 2 = 1.28$	$1.19 \times 2 = 2.38$	1.85
(2.)	120	$0.78 \times 2 = 1.56$	$1.28 \times 2 = 2.56$	1.64
(3.)	140	$0.83 \times 2 = 1.66$	$1.37 \times 2 = 2.74$	1.65
(4.)	160	$0.85 \times 2 = 1.70$	$1.41 \times 2 = 2.82$	1.65
(5.)	180	$0.88 \times 2 = 1.76$	$1.48 \times 2 = 2.96$	1.68

PHASOR DIAGRAM OF 3-PHASE DELTA CONNECTED LOAD

$I_L = \sqrt{3} I_{ph}$

$V_L = V_{ph}$

Phase currents: I_R, I_Y, I_B

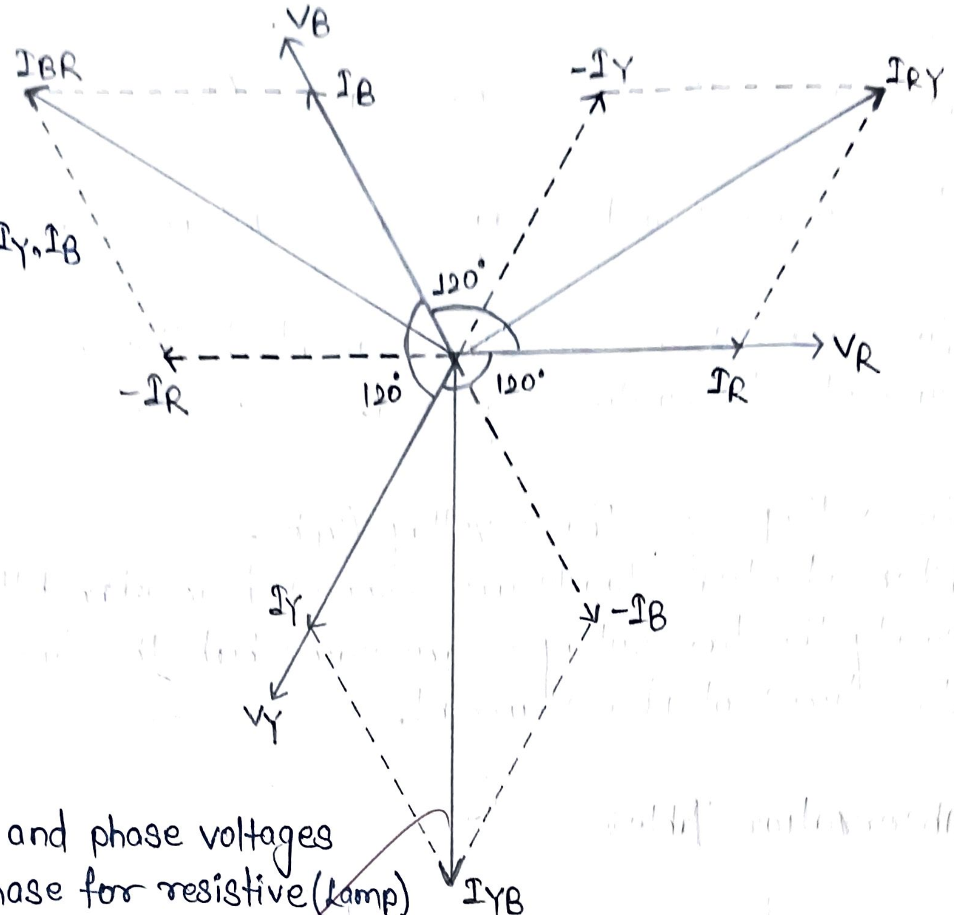
Line currents:

I_{RY}, I_{YB}, I_{BR}

$\vec{I}_{RY} = \vec{I}_R - \vec{I}_Y$

$\vec{I}_{YB} = \vec{I}_Y - \vec{I}_B$

$\vec{I}_{BR} = \vec{I}_B - \vec{I}_R$



Phase currents and phase voltages are in same phase for resistive (lamp) load.

* **Calculation:**

$\Rightarrow$ Average value $= \dfrac{1.85 + 1.64 + 1.65 + 1.65 + 1.68}{5}$

$= \dfrac{8.47}{5}$

$= 1.69$

$\Rightarrow$ % Error $= \dfrac{1.73 - 1.69}{1.73} \times 100$

$= 2.31\%$

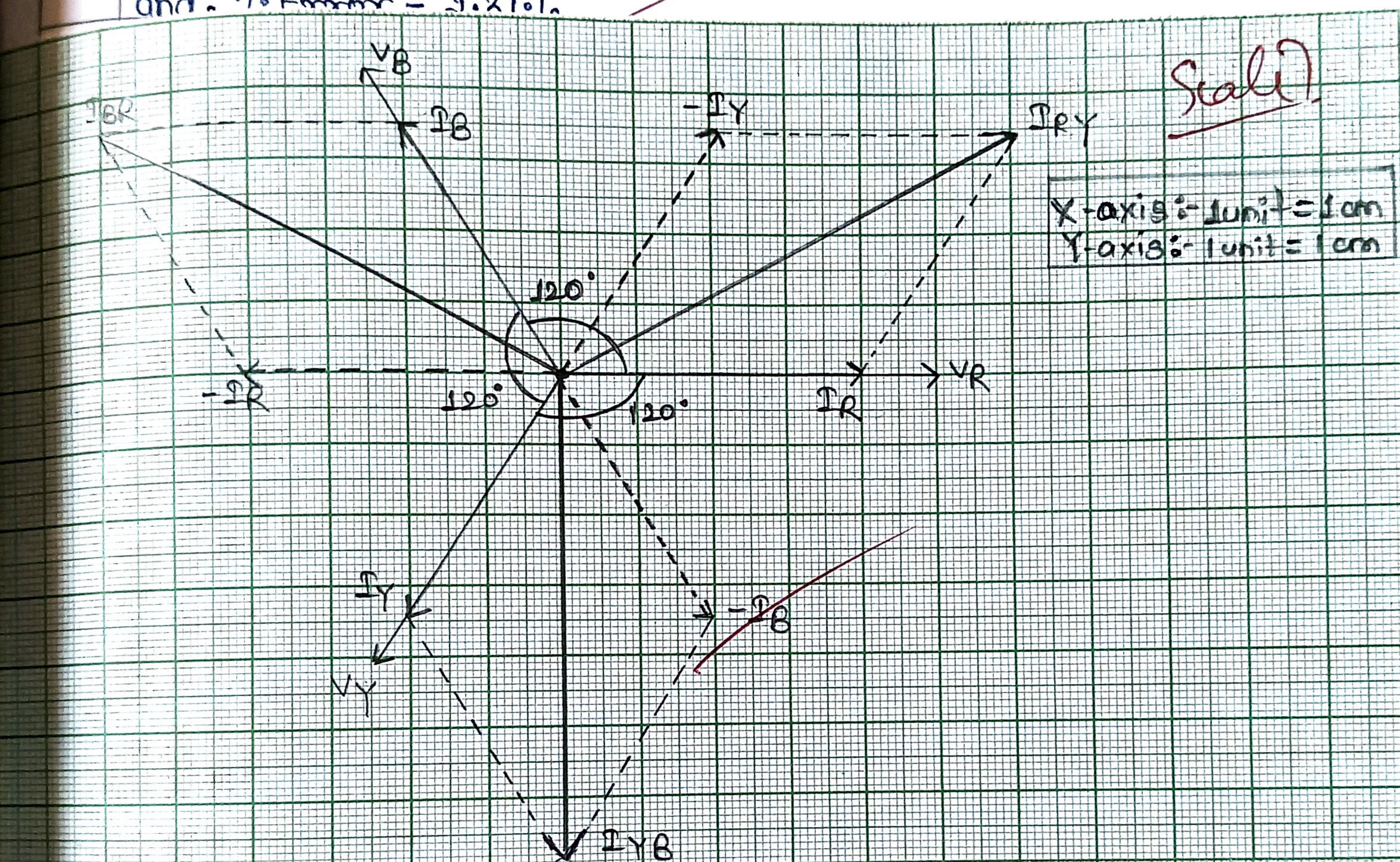
Date

Expt. No. 5 Page No. 16

* Result :-

Average value of the ratio of I_L upon I_{ph} $(I_L / I_{ph}) = 1.69$

and % error = 2.31%



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(v) The connections should be verified to prevent short circuits and ensure correct phase alignment.

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Result:-

Average value of the ratio of I_L upon I_{ph} $(I_L / I_{ph}) = 1.69$

% error = 2.31%

Precautions:-

i) Circuit connections should be checked carefully before switching on the power to prevent incorrect wiring.

ii) Properly rated measuring instruments must be used to ensure accurate readings and avoid damage.

iii) The supply voltage should be kept stable to prevent fluctuations that may affect measurements.

iv) The circuit should be de-energized before making any modifications to minimize the risk of electric shock.

v) The connections should be verified to prevent short circuits and ensure correct phase alignment.

19/02/25

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EXPERIMENT NO. 6

* **Name :-** Measurement of Three-Phase Power.

* **Objective :-** (1) To measure the power input to three-phase star connected resistive load using two wattmeter method.

(2) To obtain the phasor diagram.

* **Apparatus :-**

S. No.	Equipment/ Meter	Specification	Quantity
(1)	AC Ammeter	0-10A	01
(2)	AC Voltmeter	0-500V	01
(3)	Wattmeter	500V, 10A	01
(4)	3-phase star connected load lamp		01
(5)	Connecting wires	1.5mm	As required

* **Theory :-**

Real power in balanced (or unbalanced) 3 phase circuits can be measured by using two wattmeters connected in any two lines of a three-phase wire system. Suppose that the reading of the first wattmeter is W_1 and the second wattmeter is W_2.

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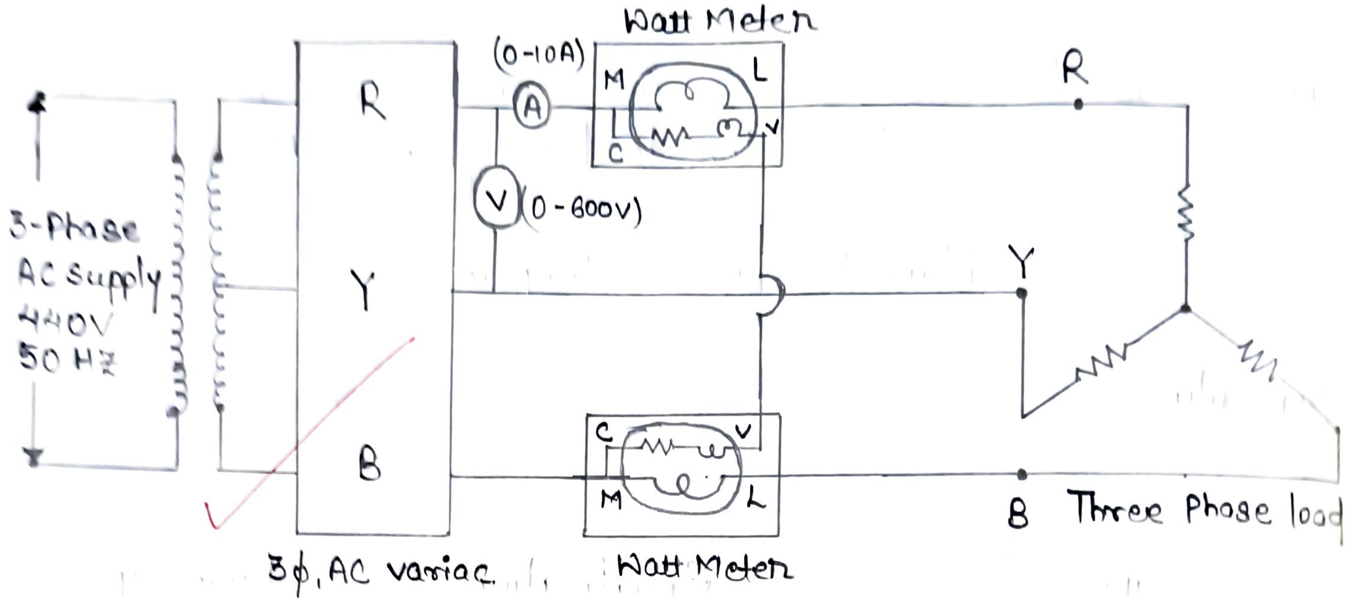
* Circuit Diagram :-



* Real power = $W_1 + W_2$
* Reactive power = $\sqrt{3}(W_1 - W_2)$
* $\tan\phi = \frac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}$
* Power Factor = $\cos\phi$
* **Observation Table :-**

S. No.	V volts (V) x 2	Load (W)	I (ampere) (A) x 2	W_1 (watt) (W) x 2	W_2 (watt) (W) x 2
(1.)	180x2=360	0	0.25x2=0.5	5x2=10	7x2=14
(2.)	360	300	0.3x2=0.6	15x2=30	20x2=40
(3.)	360	600	0.4x2=0.8	40x2=80	50x2=100
(4.)	360	900	0.5x2=1.0	50x2=100	70x2=140
(5.)	360	1200	0.6x2=1.2	60x2=120	125x2=250
(6.)	360	1500	0.7x2=1.4	90x2=180	195x2=390

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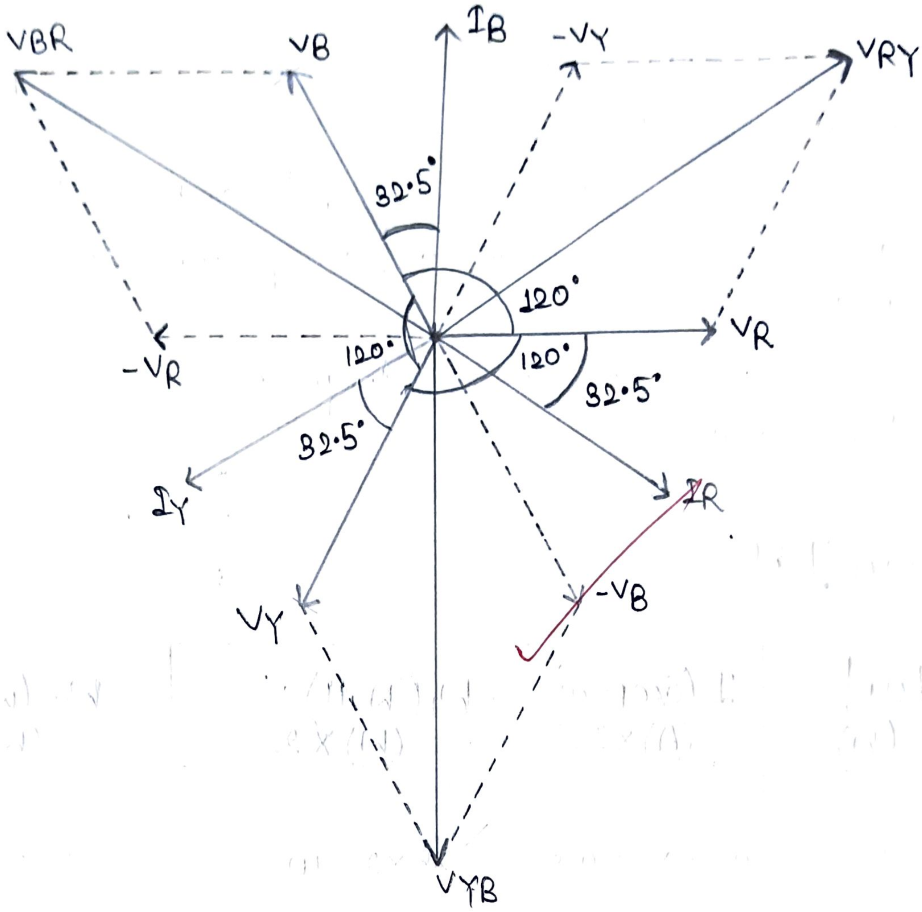
PHASOR DIAGRAM OF 3-PHASE POWER



*Calculation:- For Load = 1500W

⇒ Real power $= W_1 + W_2 = 180 + 390 = 570W$

⇒ Reactive power $= \sqrt{3}(W_2 - W_1) = \sqrt{3}(390-180) = 363.72$ VAR

⇒ $\tan\phi = \dfrac{\sqrt{3}(W_2 - W_1)}{W_1 + W_2}$

⇒ $\tan\phi = \dfrac{\sqrt{3}(390-180)}{180+390} = \dfrac{363.72}{570} = 0.638 \Rightarrow \phi = \tan^{-1}(0.638)$

⇒ $\phi = 32.537°$

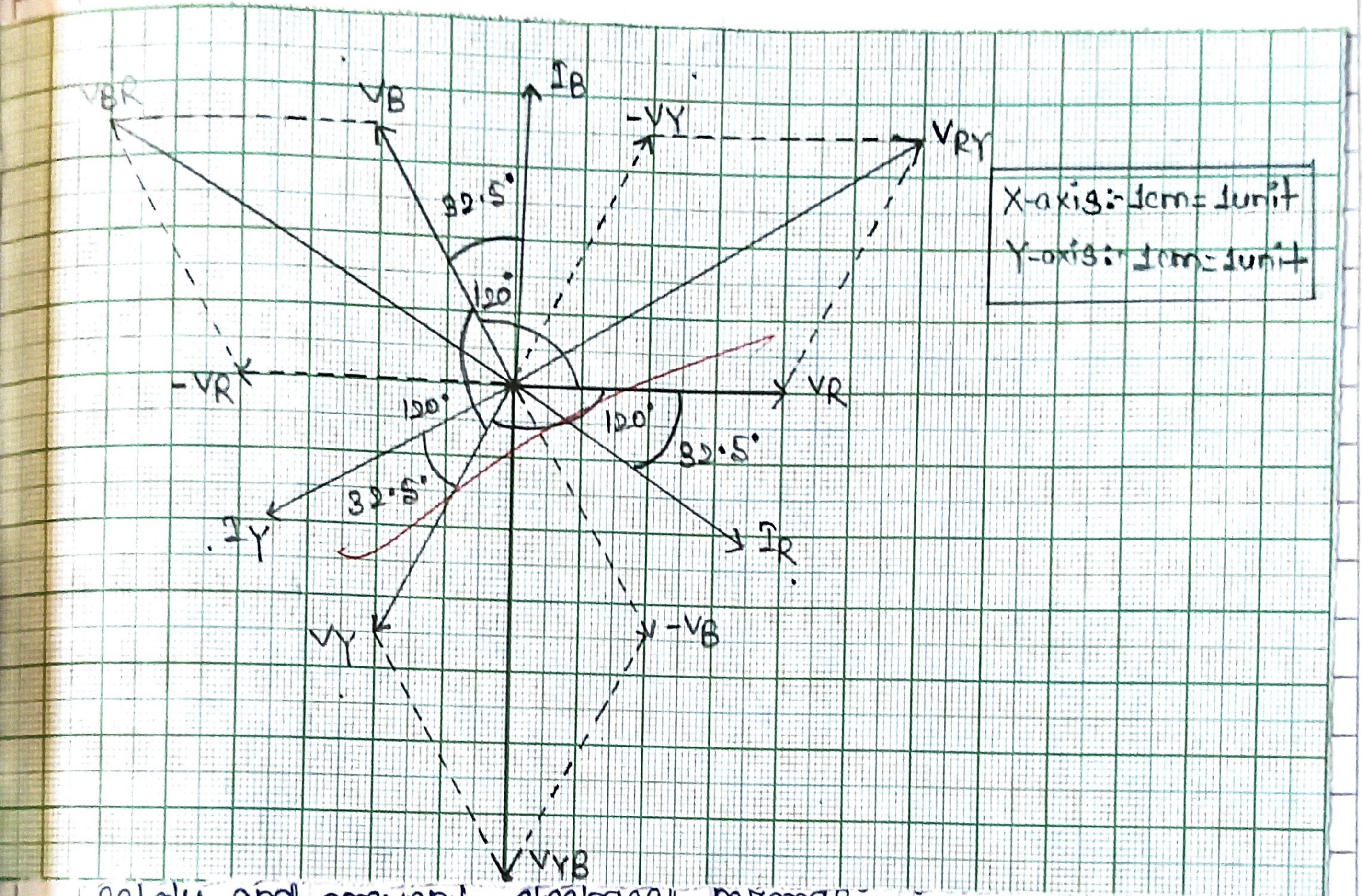
and, $\cos\phi = \cos(32.537°) = 0.84304$

Date

Expt. No. 6 Page No. 19

* Result :-

Real (active) power = 570W,
Reactive power = 363.72 VAR.



safety and prevent electrical hazards.

(v) The circuit should be de-energized before making any modifications to avoid the risk of electric shock.

5/3/25

Teacher's Signature

* **Result:-**

Real (active) power = 570W,
Reactive power = 363.72 VAR,
$\tan\phi = 0.638$,
and, Power factor = $\cos\phi = 0.843$

* **Precautions:-**

(i) All circuit connections should be checked properly before switching on the power to avoid incorrect wiring.

(ii) Properly rated measuring instruments must be used to ensure accurate readings and prevent damage.

(iii) The supply voltage should be kept stable to avoid fluctuations that may affect measurements.

(iv) The neutral point should be properly grounded to ensure safety and prevent electrical hazards.

(v) The circuit should be de-energized before making any modifications to avoid the risk of electric shock.

5/8/25

Teacher's Signature

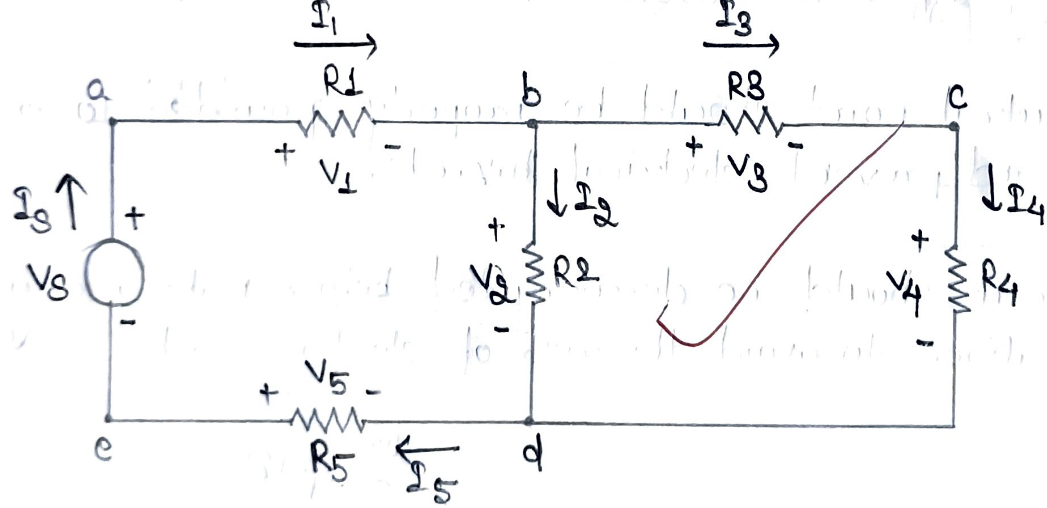


figure 1

EXPERIMENT NO. 7

* **Name:-** KCL and KVL verification.

* **Objective:-** To verify KCL and KVL for a given electrical circuit.

* **Apparatus:-**

S. No.	Equipment/ Meter	Specification	Quantity
(1.)	DC Ammeter	0-2A/0-1A	03
(2.)	DC voltmeter	0-50V	03
(3.)	Single phase Autotransformer	0-240V	01
(4.)	Connecting wires	1.5mm	As required

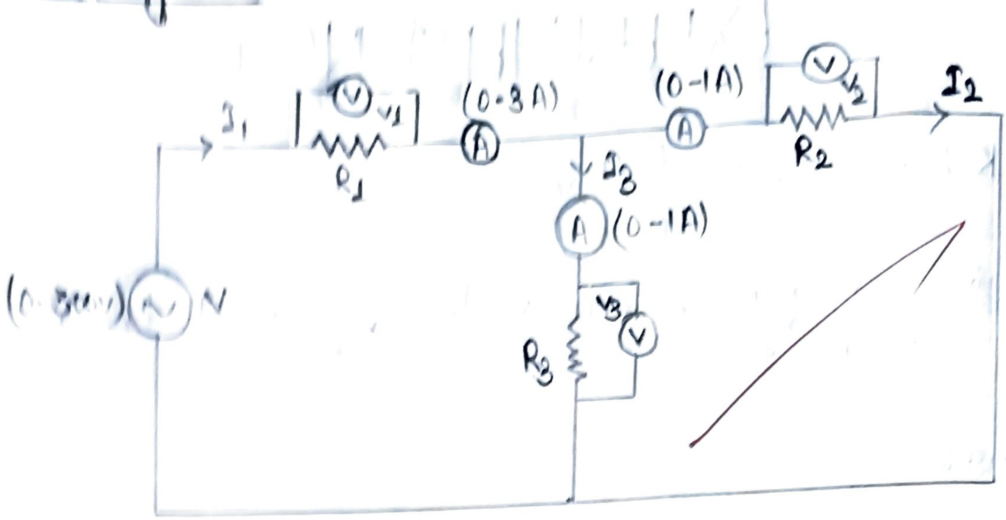
* **Theory:-**

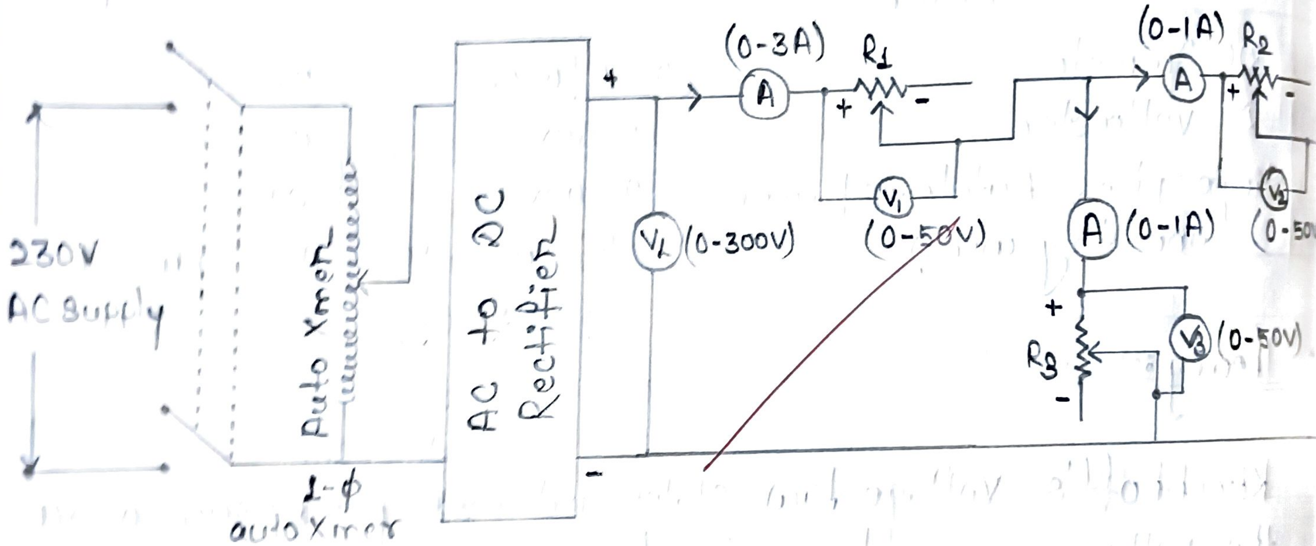
Kirchhoff's voltage law states that the algebraic sum of all the voltages around any closed path (loop or mesh) is zero. Applying kirchoff's voltage law to the first and the second loops in the circuit shown in figure 1 yields:

Loop 1:- $-V_s + V_1 + V_2 + V_5 = 0$ ---- (1)

Loop 2:- $-V_2 + V_3 + V_4 = 0$ ---- (2)

* Circuit Diagram:-





Kirchhoff's Current Law states that the algebraic sum of all the currents at any node is zero. Applying Kirchhoff's current law to the first four nodes in the circuit shown in figure 1 yields the following equations:

Node a: $-I_3 + I_1 = 0$ ---- (3)

Node b: $-I_1 + I_2 + I_3 = 0$ --- (4)

Node c: $-I_3 + I_4 = 0$ ---- (5)

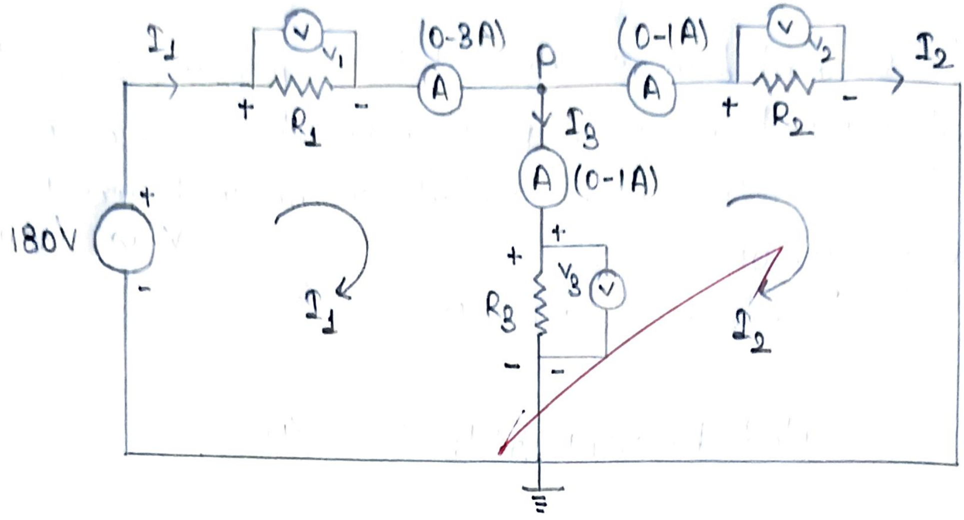
Node d: $-I_2 + I_5 - I_4 = 0$ --- (6)

* **Observation Table:-**

S. No.	Supply voltage (V_S) volts	I_1 (Amp.)	I_2 (Amp.)	I_3 (Amp.)	V_1 (volts)	V_2 (volts)	V_3 (volts)
(1.)	80	0.25	0.09	0.12	53	27	27
(2.)	100	0.30	0.12	0.14	66	33	33
(3.)	120	0.40	0.16	0.18	79	40	40
(4.)	140	0.45	0.19	0.21	94	48	48
(5.)	160	0.50	0.22	0.24	106	54	54
(6.)	180	0.58	0.25	0.27	120	60	60

Teacher's Signature

* **Calculation:-**



For supply voltage (V_s) = 180V

Applying Kirchhoff's Voltage Law (KVL),

Mesh 1:- $\Rightarrow V - V_1 - V_3 = 0$

$\Rightarrow 180 - 120 - 60 = 0$

$\Rightarrow \boxed{\cancel{180} - \cancel{180} = 0}$

Mesh 2:- $\Rightarrow V_3 - V_2 = 0$

$\Rightarrow \boxed{\cancel{60} - \cancel{60} = 0}$

and, $I_3 = I_1 - I_2$

$\Rightarrow 0.27 = 0.52 - 0.25$

$\Rightarrow \boxed{0.27 = 0.27}$

$\therefore$ KVL verified.

Now, applying Kirchhoff's Current Law (KCL),

At Node P:- $\Rightarrow -I_1 + I_2 + I_3 = 0$

$\Rightarrow -0.52 + 0.25 + 0.27 = 0$

$\Rightarrow -0.\cancel{52} + 0.\cancel{52} = 0$

$\Rightarrow \boxed{0 = 0}$

$\therefore$ KCL verified.

* **Result:-**

The KCL and KVL verification experiment was conducted successfully.

* **Precautions:-**

(i) Connection should be checked properly to ensure no short circuits or incorrect readings occur.

(ii) Properly rated instruments must be used to prevent damage or inaccurate readings.

(iii) Overloading should be avoided to ensure the safety of the circuit and measuring instruments.

(iv) A stable supply voltage should be maintained to avoid fluctuations that could affect measurement accuracy.

(v) Insulated tools should be used to minimize the risk of electric shock.

Jayalaxmi 19/3/25

Teacher's Signature

EXPERIMENT NO. 8

* **Name :-** Volt-Ampere method for measuring resistance.

* **Objective :-** (1) To measure resistance of an incandescent lamp.

(2) To draw the V-I characteristics of an incandescent lamp.

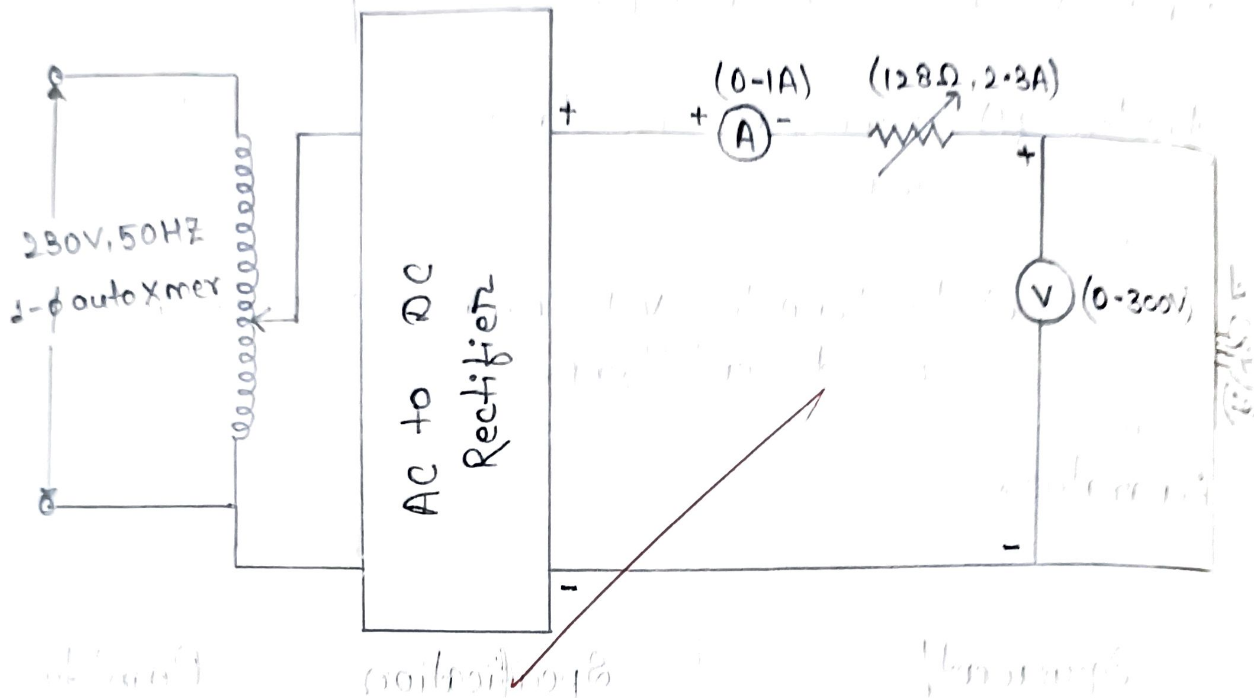
* **Apparatus :-**

S. No.	Equipment/ Meter	Specification	Quantity
(1.)	Incandescent lamp	200W	01
(2.)	Rheostat	128 Ω, 2.3A	01
(3.)	D.C. Voltmeter	0-300V	01
(4.)	D.C. Ammeter	0-2.5A	01
(5.)	Connecting wires	1.5mm	As required
(6.)	Single-phase auto-transformer	0-240V	01
(7.)	Rectifier	-	01

* **Theory :-**

For many materials resistance R is a constant, independent of I and V. The linear relationship between V and I. Here, $V = IR$ is called Ohm's Law.

* **Circuit Diagram:-**



Electrical resistance R is defined by

$$\boxed{R = \frac{V}{I}}$$

where, V is the potential difference (or voltage drop) across the resistor and I is the current through it. The unit of resistance is the Ohm(Ω).

If R=0 in a circuit, it is called "shorted" circuit and if R=infinity, it is called an "open" circuit.

* **Observation Table:-**

S.No.	Volt (V)	I (Ampere)	R=V/I (Ω)
(1.)	70	0.35	200
(2.)	80	0.40	200
(3.)	90	0.45	200
(4.)	100	0.48	208.33
(5.)	110	0.52	211.53

* Calculations:-

$$\text{Average value }(R) \; (R_{avg}) = \left(\frac{200+200+200+208.33+211.53}{5}\right)\Omega$$

$$= \left(\frac{1019.86}{5}\right)\Omega$$

$$= 203.97\,\Omega$$

and, from graph

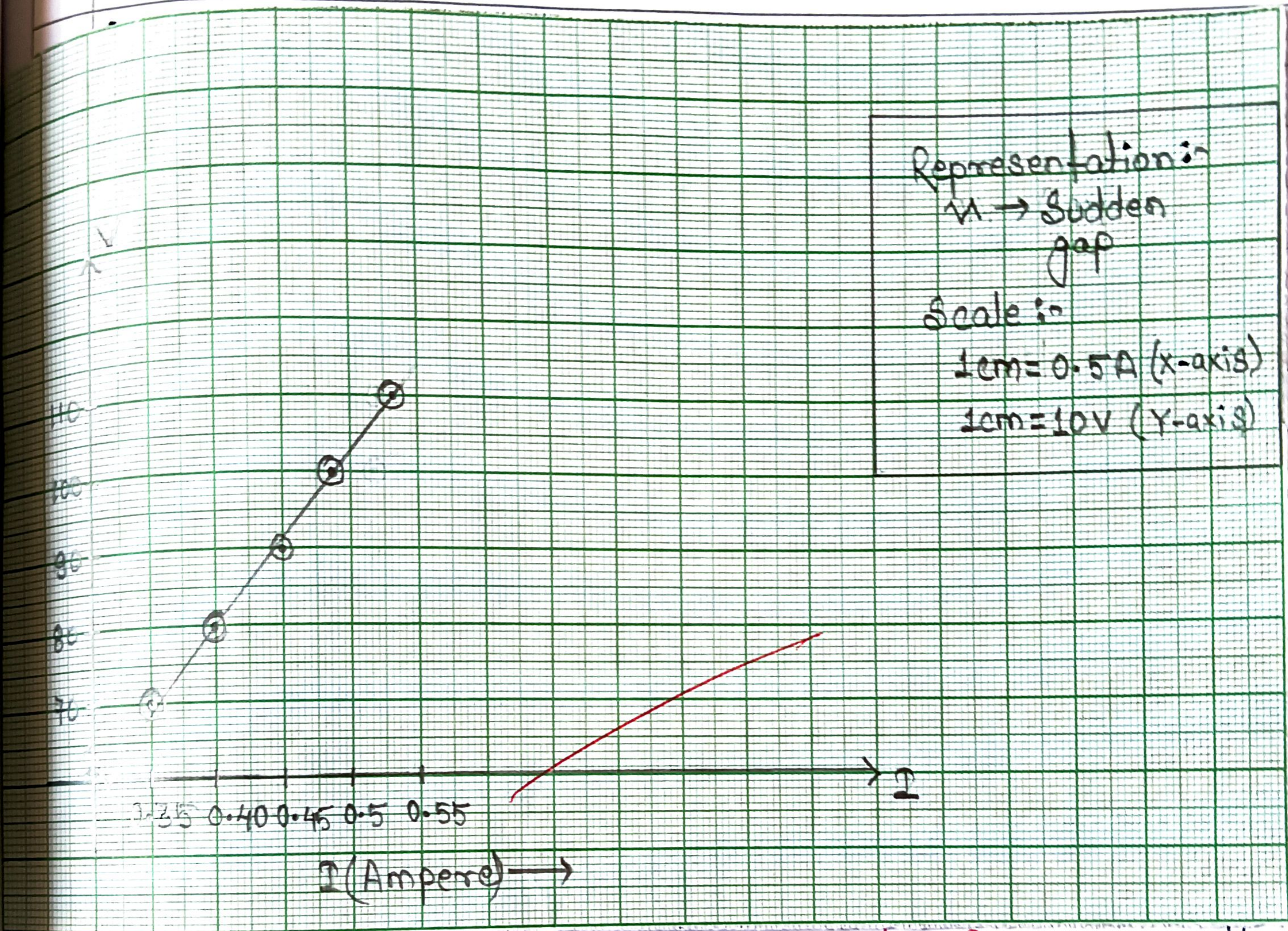
$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{110-100}{0.52-0.48} = 250\,\Omega$$

Date

Expt. No. 8 Page No. 25

* **Result :-**

The average value of resistance of incandescent lamp = 203.97Ω and, from graph slope = 250Ω



electric shock.

26/3/25

Teacher's Signature

- **Result:-**

The average value of resistance of incandescent lamp = 203.97 Ω
and from graph slope = 250 Ω

- **Precautions:-**

(i) Connection should be checked properly to ensure no short circuits or incorrect readings occur.

(ii) Properly rated instruments must be used to prevent damage or inaccurate readings.

(iii) Overloading should be avoided to ensure the safety of the circuit and measuring instruments.

(iv) A stable supply voltage should be maintained to avoid fluctuations that could affect measurement accuracy.

(v) Insulated tools should be used to minimize the risk of electric shock.

Tejaland
26/3/25

EXPERIMENT NO. 9

* **Name:-** AC R-L-C Series circuit.

* **Objective:-** (1) To obtain the current and voltage distribution in AC R-L-C series circuit.

(2) To draw the phasor diagram.

* **Apparatus:-**

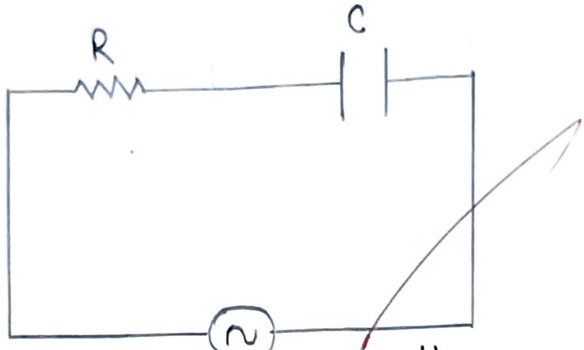
S. No.	Equipment/ Meter	Specification	Quantity
(1.)	AC Ammeter	0-3A	01
(2.)	AC voltmeter	0-250V	01
(3.)	Rheostat	200Ω, 1.8A	01
(4.)	Choke coil	4 Henry	01
(5.)	Capacitor	4μF	01
(6.)	Single phase autotransformer	0-240V	01
(7.)	Connecting wires	1.5mm	As required

* **Theory:-**

If the current through a passive component is given by

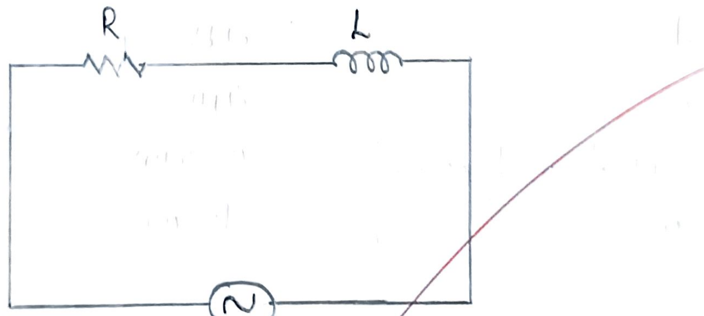
$$i(t) = I\sin(\omega t) = I\sin(2\pi f) \quad \text{-----} (1)$$

Then the voltage across the component also varies sinusoidal, but



$V(t) = V\sin(\omega t + \phi)$

Figure 1



$V(t) = V\sin(\omega t + \phi)$

Figure 2

with a phase that depends on the component. for a resistor the voltage is in phase with the current. for a capacitor the voltage lags the current by 90° and for an inductor the voltage leads the current by 90°. The peak(or rms) current-voltage relationships for a resistor, capacitor and inductor are

$$V_R = I X R, \text{----} (2)$$

$$V_C = I X_C = (I/\omega C) \text{---} (3)$$

$$\text{and, } V_L = I X_L = I\omega L \text{---} (4)$$

Series RC circuit,

In a series RC circuit, since the currents are the same then the voltage sources R and C are 90° out of phase. Consequently, the total voltage across the combination is, (Fig 1)

$$V = I\sqrt{R^2 + X_C^2}$$

Series RL circuit,

In a series RL circuit, the voltages across R and L will also be 90° out of phase. Thus (Fig 2)

$$V = I\sqrt{R^2 + X_L^2}$$

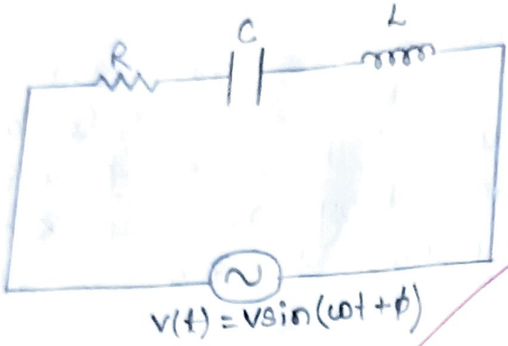
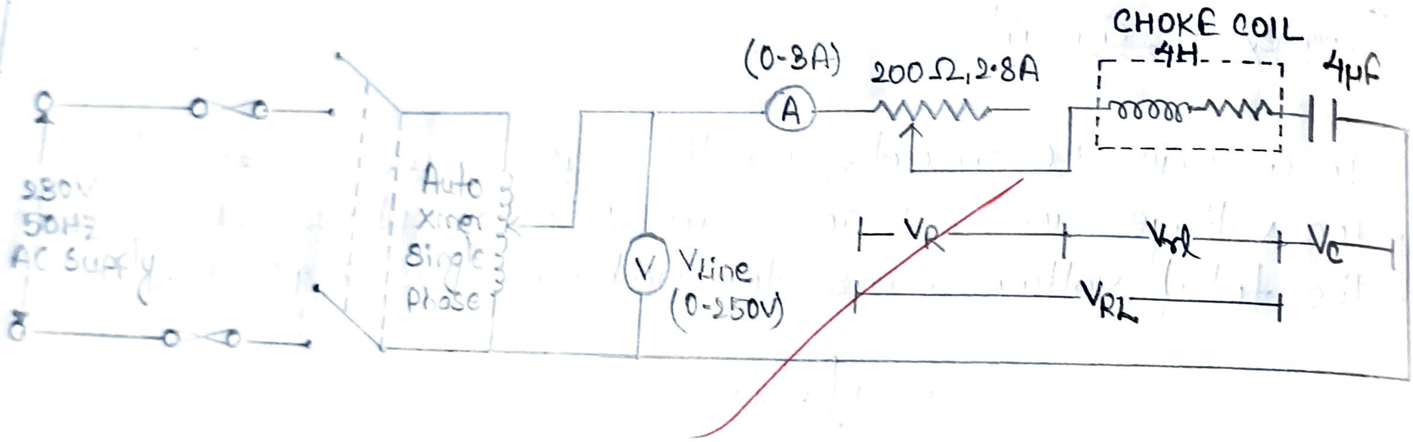


Figure 3

*** Circuit Diagram:-**



Series RLC circuit.

(Fig 3) In a series RLC circuit, since the voltage across L leads the current by 90° and the voltage across C lags the current by 90°, then the voltages across L and C are 180° out of phase. Consequently, we have

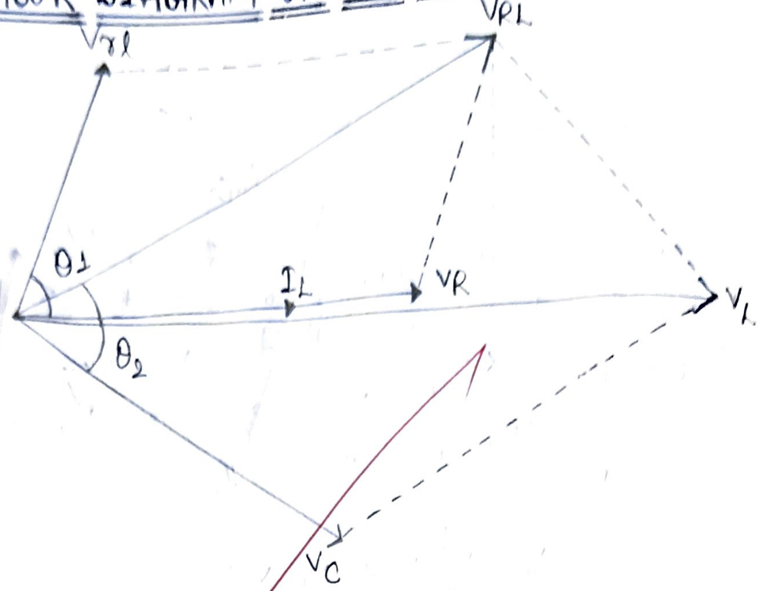
$$V = I\sqrt{R^2 + (X_L - X_C)^2}$$

It can be concluded that the voltage across a resistance is in phase with the current through it, the voltage across inductance leads the current by 90° and the voltage across a capacitance lags by 90°.

* **Observation Table :-**

S.No.	I_L (Ampere)	V_{Line} (volt)	V_R (volt)	V_{RL} (volt)	V_C (volt)	V_{rL} (volt)
(1.)	0.13	120	38	87	175	70
(2.)	0.20	140	45	104	208	83
(3.)	0.22	160	51	118	237	95
(4.)	0.23	180	59	136	272	109
(5.)	0.25	200	65	151	302	120
(6.)	0.27	220	72	165	333	132

PHASOR DIAGRAM OF AC RLC SERIES CIRCUIT



* Calculations :-

for $I_L = 0.27A$ and $V_L = 220V$ (θ_1)

$$\Rightarrow V_{RL}^2 = V_R^2 + V_{rl}^2 + 2V_R V_{rl} \cos\theta_1$$

$$\Rightarrow 165^2 = 72^2 + 132^2 + 2(72)(132)\cos\theta_1$$

$$\Rightarrow \cos\theta_1 = \frac{4617}{19008} = 0.2428$$

$$\Rightarrow \theta_1 = \cos^{-1}(0.2428)$$

$$\therefore \boxed{\theta_1 = 75.95^\circ}$$

and, $\Rightarrow 220V = V_L$ and $I_L = 0.27A$ (θ_2)

$$\Rightarrow V_L^2 = V_{RL}^2 + V_C^2 + 2V_{RL}V_C \cos\theta_2$$

$$\Rightarrow 220^2 = 165^2 + 333^2 + 2(165)(333)\cos\theta_2$$

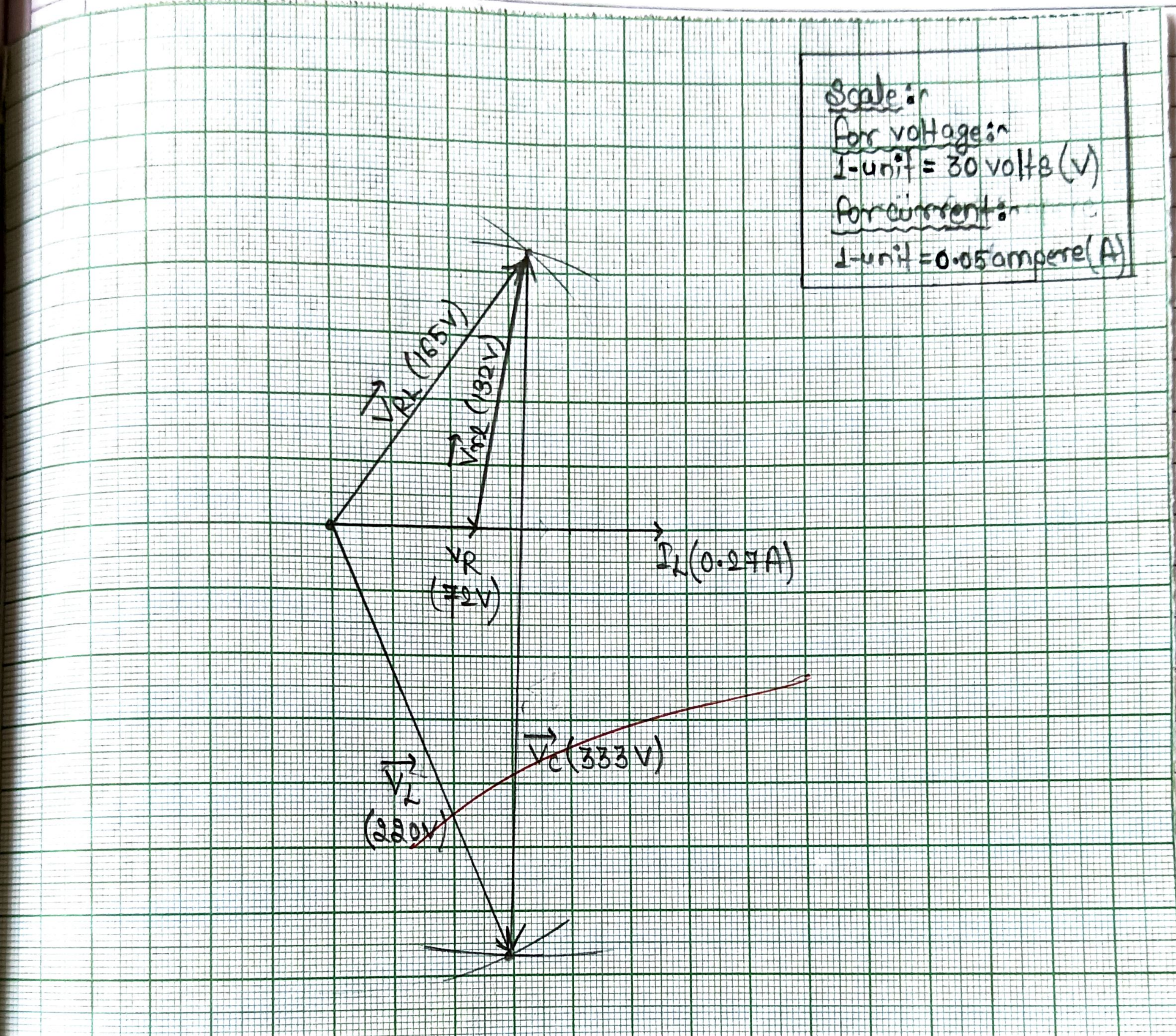
$$\Rightarrow \cos\theta_2 = \frac{-89714}{109890} = -0.8163$$

$$\Rightarrow \theta_2 = \cos^{-1}(-0.8163)$$

$$\therefore \boxed{\theta_2 = 144.72^\circ}$$

* Result:-

Value of $\theta_1 = 75.95°$



electric shock.

Result:-

Value of $\theta_1 = 75.95^\circ$
and value of $\theta_2 = 144.72^\circ$

The above experiment of AC R-L-C series circuit was conducted successfully.

Precautions:-

(i) Connection should be checked properly to ensure no short circuits or incorrect readings occur.

(ii) Properly rated instruments must be used to prevent damage or inaccurate readings.

(iii) Overloading should be avoided to ensure the safety of the circuit and measuring instruments.

(iv) A stable supply voltage should be maintained to avoid fluctuations that could affect measurement accuracy.

(v) Insulated tools should be used to minimize the risk of electric shock.

Teacher's Signature

EXPERIMENT NO. 10

* **Name :-** AC R-L-C parallel circuit.

* **Objective :-** (1) To obtain the current and the voltage distribution in AC R-L-C parallel circuit.

  (2) To draw the phasor diagram.

* **Apparatus :-**

S. No.	Equipment/ Meter	Specification	Quantity
(1)	AC Ammeter	0-3A	01
(2)	AC Voltmeter	0-250V	01
(3)	Rheostat	200Ω, 1·8A	01
(4)	Choke coil	4 Henry	01
(5)	Capacitor	4μF	01
(6)	Single phase autotransformer	0-240V	01
(7)	Connecting wires	1·5mm	As required
(8)	Fuse Box	-	01

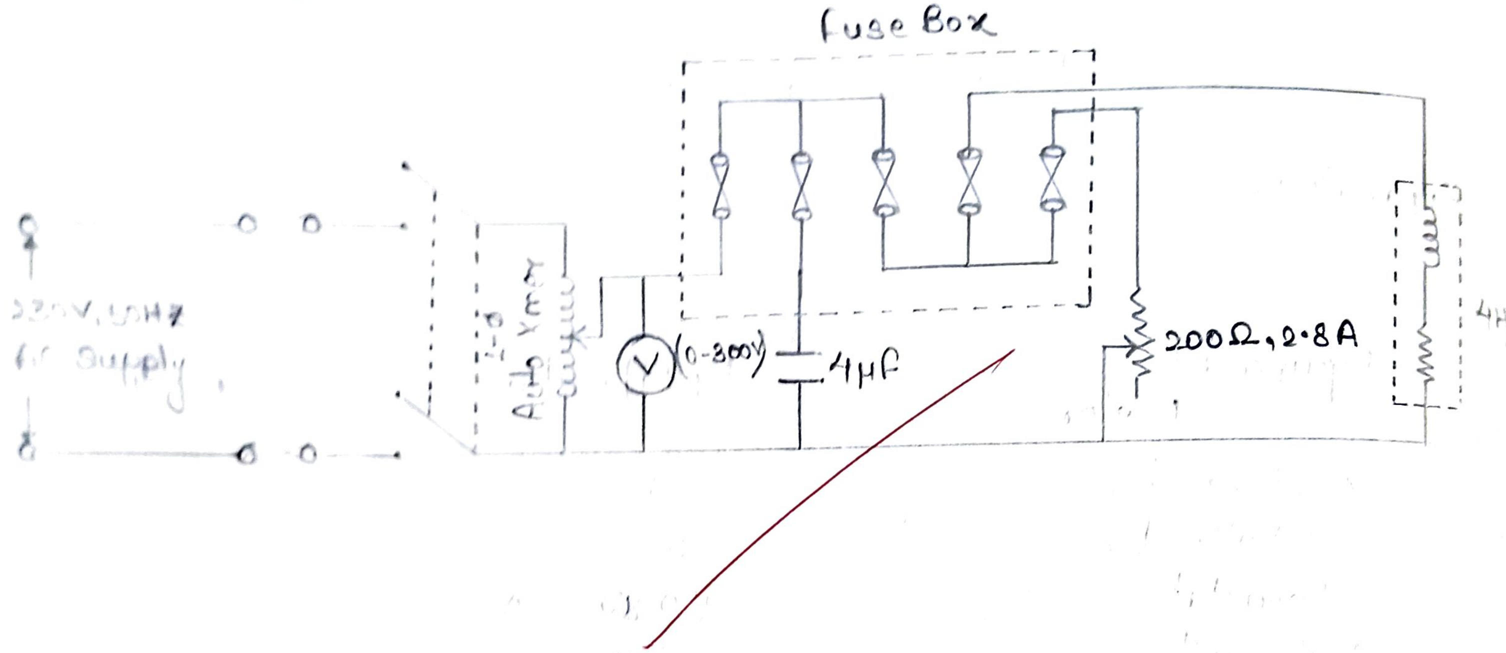
* **Theory :-**

The basic VI relationship of resistance, inductance and capacitance are given by, $I_R = V_R/R$,

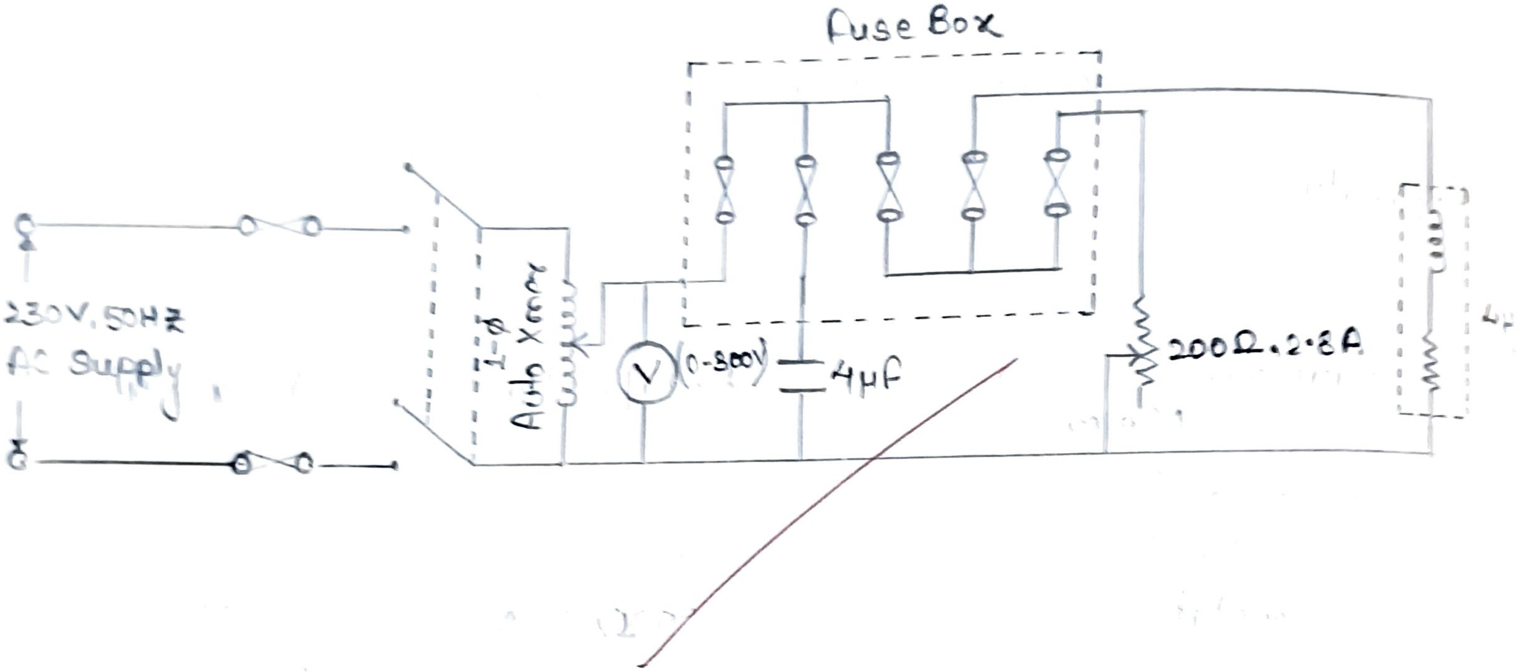
$I_L = (1/L)\int V_L dt$

and, $I_C = C dV_C/dt$

* **Circuit Diagram:**



* Circuit Diagram:



...when the voltage across each element is $V = V_m \sin(\omega t)$, the ...rents are given by, $I_R = (1/R) V_m \sin(\omega t)$.
$I_L = (1/\omega L) V_m \cos(\omega t)$.
and, $I_C = \omega C V_m \sin(\omega t + 90^\circ)$.

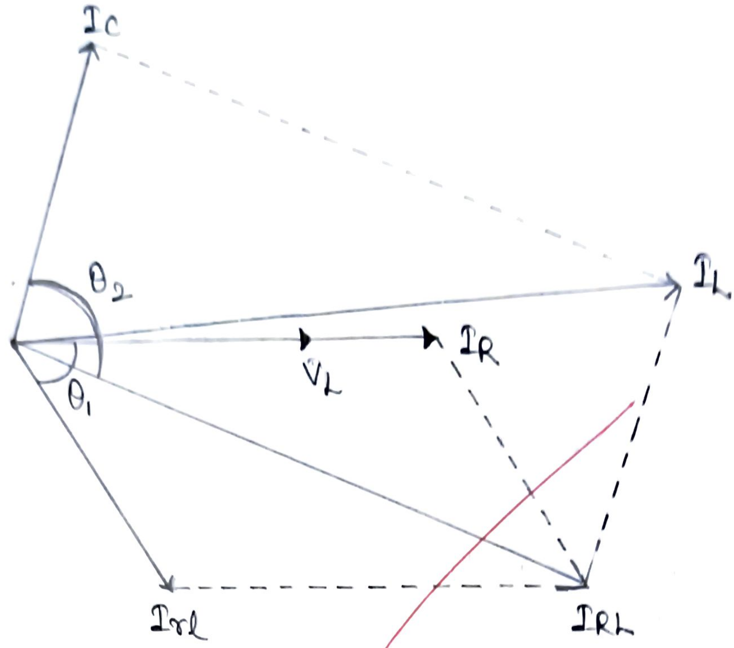
... can be concluded that, the current in a resistance is in ...ase with the voltage across it, the current in an inductance ...s the voltage by 90 degree and the current in a capacitor ...ads by 90 degree.
...e phase relations can be conventionally expressed in a ...asor diagram.

* ...bservation Table :-

S.No	V (volts)	I_L (Ampere)	I_R (Ampere)	I_{RL} (Ampere)	I_C (Ampere)	I_{rL} (Ampere)
1	10	0.47	0.40	0.51	0.01	0.23
2	30	0.58	0.47	0.63	0.05	0.28
3	50	0.64	0.53	0.68	0.08	0.33
4	70	0.71	0.59	0.76	0.12	0.37
5	90	0.82	0.67	0.88	0.20	0.44
6	100	0.89	0.70	0.96	0.22	0.49

Teacher's Signature

PHASOR DIAGRAM OF AC RLC PARALLEL CIRCUIT



* **Calculations:-**

For $V_L = 200V$ and $I_L = 0.89A$ (θ_1)

$\Rightarrow I_{RL}^2 = I_R^2 + I_{rL}^2 + 2I_R I_{rl} \cos\theta_1$

$\Rightarrow (0.96)^2 = (0.70)^2 + (0.49)^2 + 2 \times 0.70 \times 0.49 \cos\theta_1$

$\Rightarrow \cos\theta_1 = \dfrac{0.1915}{0.686} = 0.2791$

$\Rightarrow \cos\theta_1 = 0.2791$

$\Rightarrow \theta_1 = \cos^{-1}(0.2791) = 73.79°$

$\therefore \boxed{\theta_1 = 73.79°}$

and, $V_L = 200V$ and $I_L = 0.89A$ (θ_2)

$\Rightarrow I_L^2 = I_{RL}^2 + I_C^2 + 2I_{RL} I_C \cos\theta_2$

$\Rightarrow (0.89)^2 = (0.96)^2 + (0.22)^2 + 2 \times 0.96 \times 0.22 \cos\theta_2$

$\Rightarrow \cos\theta_2 = \dfrac{-0.1779}{0.4224} = -0.2445$

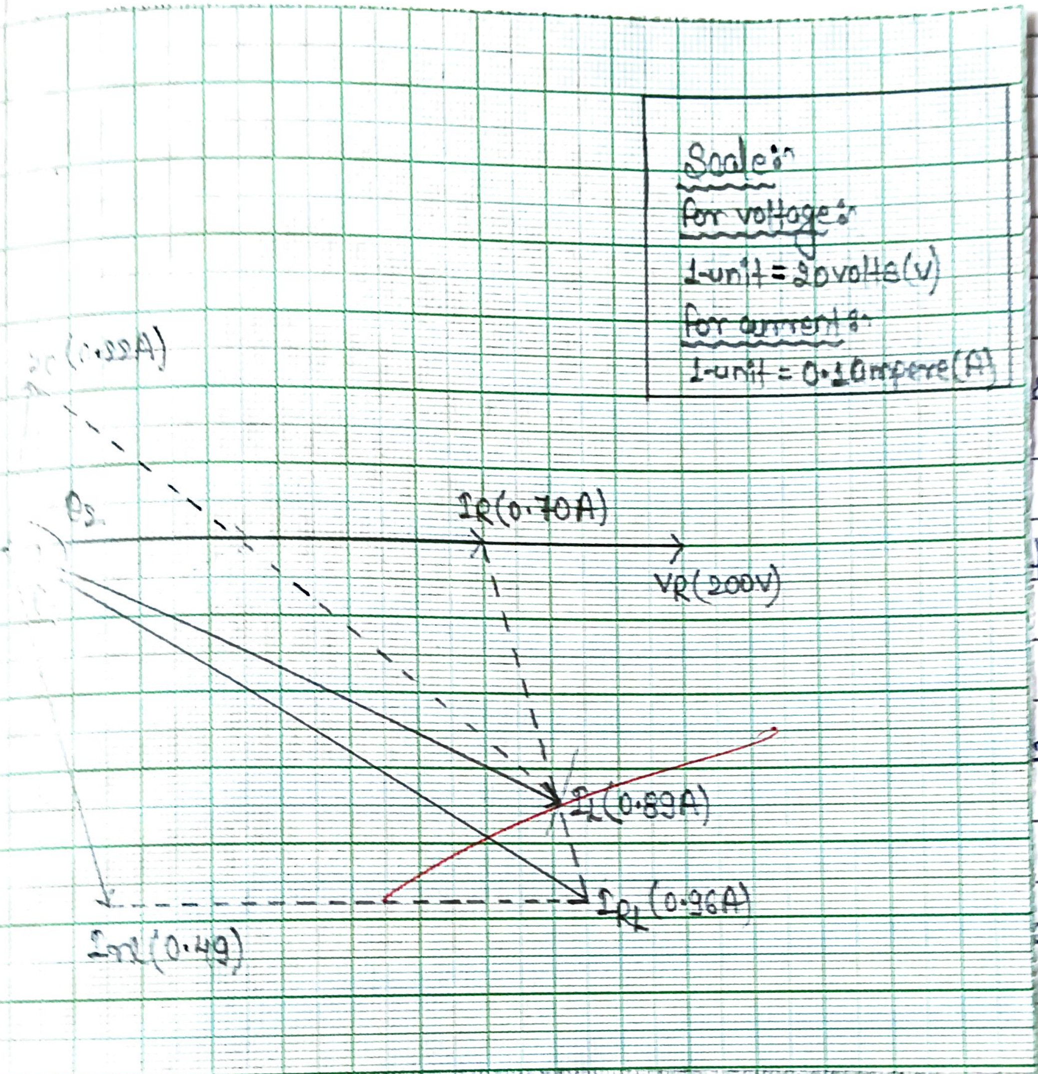
$\Rightarrow \theta_2 = \cos^{-1}(-0.2445) = 104.15°$

$\therefore \boxed{\theta_2 = 104.15°}$

* **Result:**

Value of $\theta_1 = 73.79°$

and, value of $\theta_2 = 104.15°$



conducted

short

damage

of the

tuations

(v) Insulated tools should be used to minimize the risk of electric shock.

* **Result :-**

Value of $\theta_1 = 78.79°$
and, value of $\theta_2 = 104.15°$

The above experiment of AC R-L-C parallel circuit was conducted successfully.

* **Precautions :-**

(i) Connection should be checked properly to ensure no short circuits or incorrect readings occur.

(ii) Properly rated instruments must be used to prevent damage or inaccurate readings.

(iii) Overloading should be avoided to ensure the safety of the circuit and measuring instruments.

(iv) A stable supply voltage should be maintained to avoid fluctuations that could affect measurement accuracy.

(v) Insulated tools should be used to minimize the risk of electric shock.

Rajalwal
2/4/25