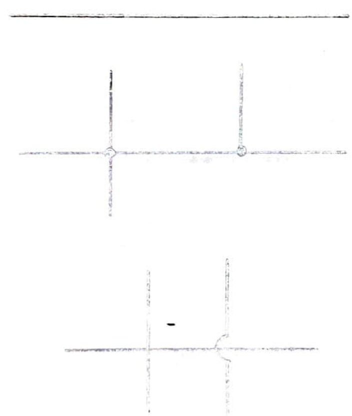
Wire Symbols



Ground Symbols

Date

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Experiment - 1

Aim: To study different types of electrical symbols.

Component name	Meaning
Wire symbols	
• Electrical wire	- Conductor of electric current.
• Connected wire	- Connected crossing
• Not connected wire	- wires are not connected
Ground symbols	
• Earth Ground	- Used for zero potential reference and electrical shock protection
• Chassis Ground	- Connected to the chasis of the circuit
• Digital/Common ground	

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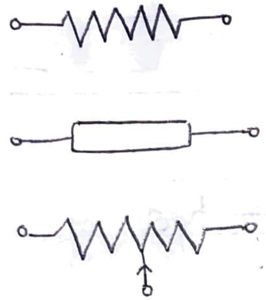
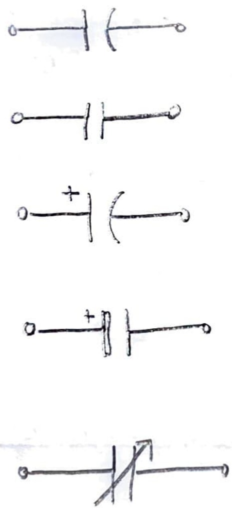
Resistor symbols



Capacitor symbols



Inductor | Coil symbols

Component Name | Meaning

Resistor symbol

- Resistor (IEEE)
- Resistor (IEC) - Resistor reduces current flow
- Potentiometer (IEEE) - Adjustable resistor - has 3 terminals

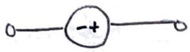
Capacitor symbol

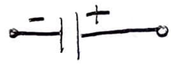
- Capacitor - Capacitor is used to store electric charge. It acts as short circuit with AC open circuit with DC
- Capacitor
- Polarized capacitor - Electrolytic Capacitor
- Polarized capacitor - Electrolytic capacitor
- Variable capacitor - Adjustable capacitance

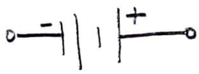
Inductor / Coil symbols

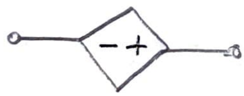
- Inductor - Coil / solenoid that generates magnetic field

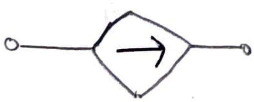
Power Supply Symbols











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Component name	meaning
• Iron Core inductor	- Includes iron
• Variable Inductor	

Power supply symbols

• Voltage Source	- Generates constant voltage
• Current source	- Generates constant current
• AC Voltage Source	- AC Voltage Source
• Generator	- Electrical voltage is generated by mechanical rotation of the generator
• Battery cell	- Generate constant voltage
• Battery	- generate constant voltage
• Controlled voltage source	- Generate voltage as a function of voltage or current of other circuit element
• Controlled current source	- Generate current as a function of voltage.

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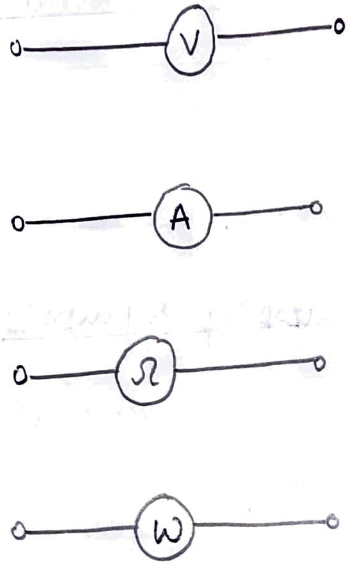
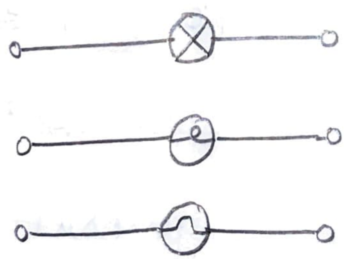
Meter symbols



Lamp | Light bulb symbols



Diode | LED symbols

Component Name — Meaning

Meters symbols

- Voltmeter - Measures voltage. Has very high resistance. Connected in parallel.
- Ammeter - Measures electric current. Has near zero resistance Connected serially
- ohmmeter - Measures resistance
- Wattmeter - Measures electric Power.

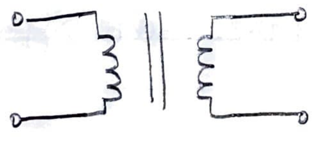
Lamp/Light bulb symbols

- Lamp/ Light bulb
- Lamp/Light bulb - Generates light when current flows through
- Lamp light bulb

Diode/LED symbols

- Diode - Diode allows current in

Misc Symbols



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Component Name.	Meaning
	one direction only (L to R)
• Zener diode	- Allow current flow in one direction, but also can flow in the reverse direction when above breakdown voltage.
• Light Emitting Diode (LED)	- LED emits light when current flows through.
• Photodiode	- Photodiode allows current flow when exposed to light

Misc. Symbols

• Motor	- Electric motor
• Transformer	- Change AC voltage from high to low or low to high.
• Electric bell	- Rings when activated
• Buzzer	- Produces buzzing sound.

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Antenna Symbolls

Component Name	Meaning
• Fuse • Fuse	- The fuse disconnects when current above threshold. Used to protect circuit from high curr- -ents.

Antenna Symbols

• Antenna/aerial • Antenna/aerial	- Transmits & recieves radio waves.

Experiment - 2

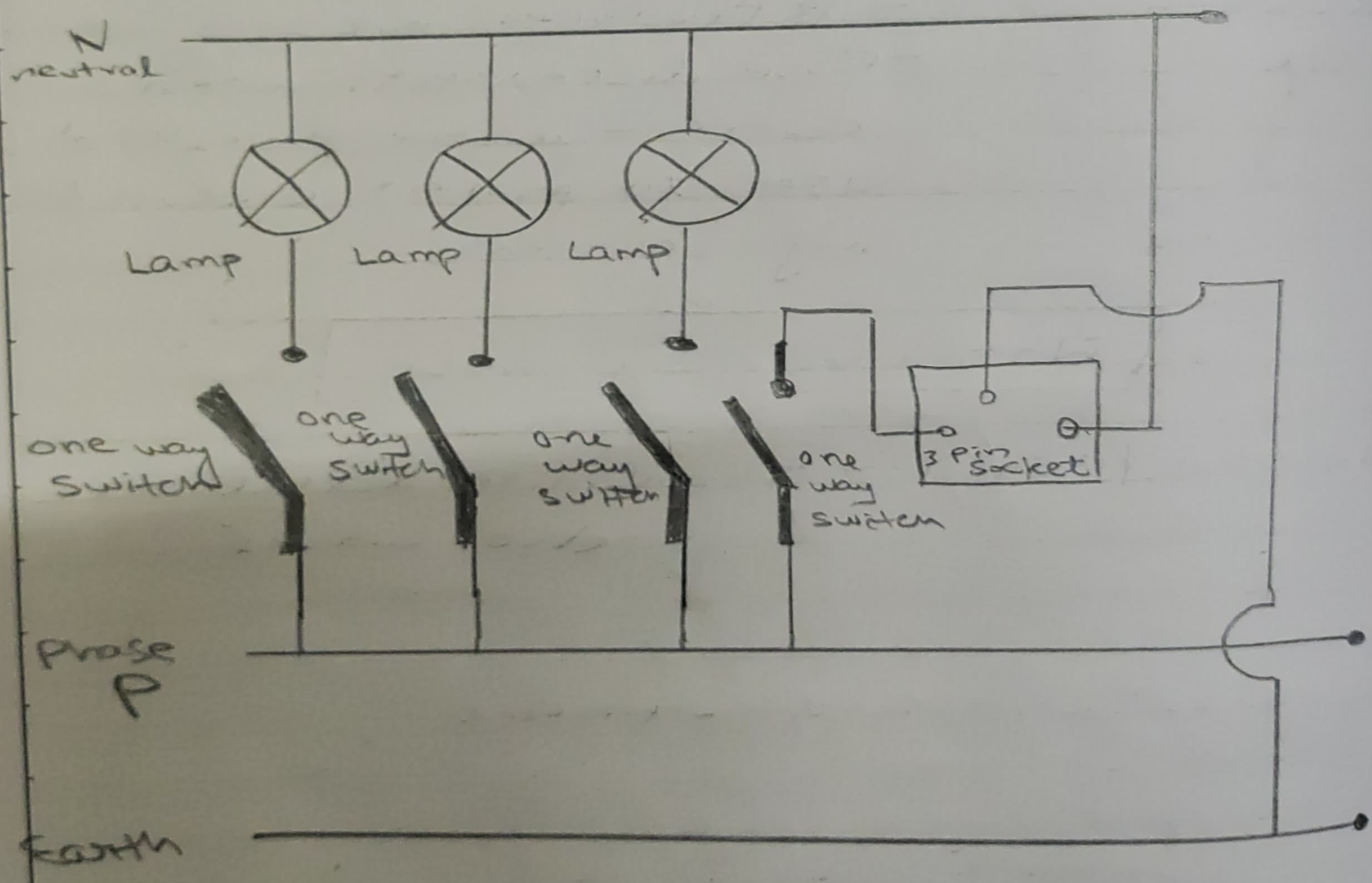
Aim - To study connection of lamp key
1) Single way switch
2) Two way switch

Apparatus - lamps with holders, connecting wires, one way ~~tow~~ two way switches, etc

Theory -
One way - A one way lighting circuit is a simple circuit that enables one circuit to be turned on or off with one witch. The single circuit may have one or more lights in it. This type of circuit uses a one way switch

Two way - A two way ~~tug~~ lighting circuit enables one circuit to be turned on or off by either of two switches. The circuit may have one or more lights in it. This type of circuit uses two of the two way switches.

2 way switching means having two or more switches in diff. locations to control the lamp. They are wired so that operation of either switch will control the light. The arrangement is often found in stair ways, with one switch upstairs & one switch downstairs, or in long hallways with a


N
neutral
Lamp
Lamp
Lamp
one way switch
one way switch
one way switch
one way switch
3 pin socket
Phase
P
Earth

switch at either end.

Here we have a schematic (fig 1) which makes it easy to visulase how this circuit works. In this state the lamp is off, changing the position of either switch will switch the live to the lamp turning it on as shown in (fig 2). If you now change the position of the other switch the circuit is broken once again

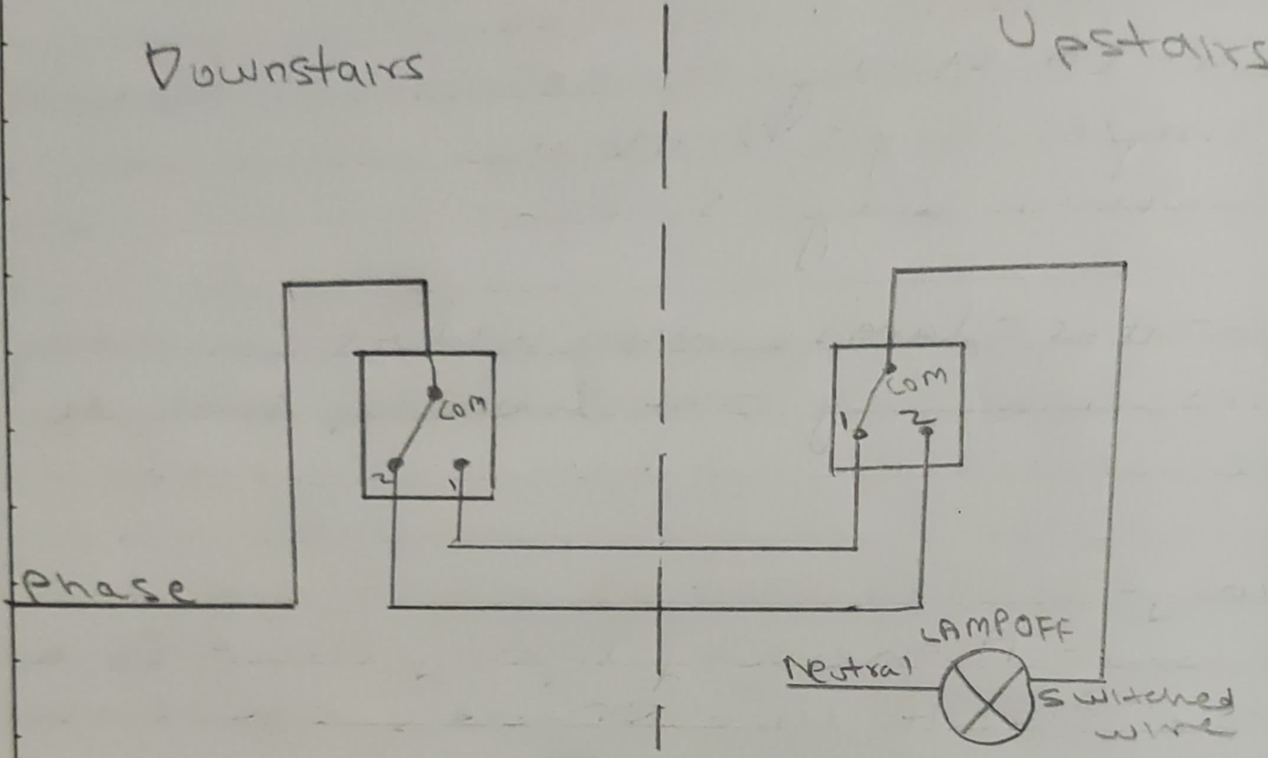


Figure 1

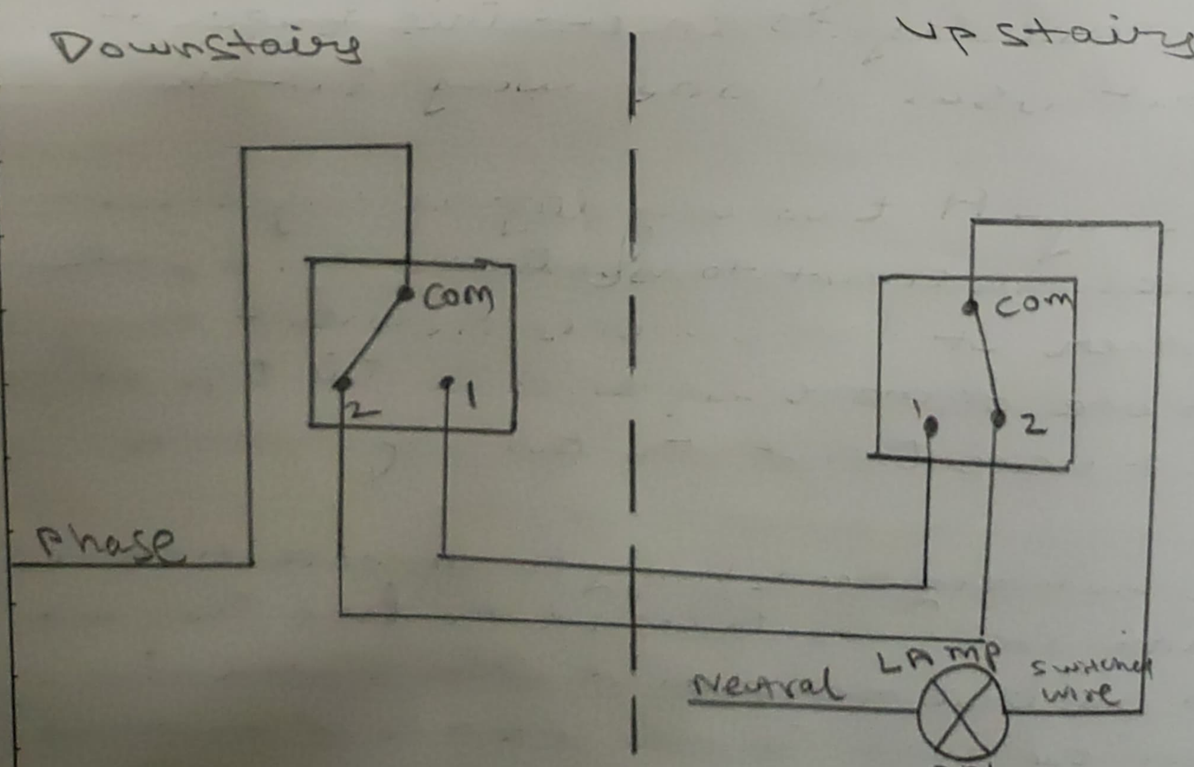


Figure 2

EXPERIMENT NO. 3

AIM: To verify thevenin & Norton's theorem

THEORY

THEVENIN'S THEOREM

The I flowing through a R_L connected across any two terminals A and B of a linear, active bilateral network is given by $V_{oc}/(R_{th}+R_L)$ where V_{oc} is the open circuit voltage known as Thevenin's voltage (V_{th}) and R_{th} is the internal resistance known as Thevenin's resistance of the network as viewed back into the open circuited network from terminals A and B with all voltage source replaced by their internal resistance (short circuit) & I sources by ∞ resistance (open circuit).

PROCEDURE: THEVENIN'S THEOREM

1. Apply a D.C. voltage from voltage source to the input terminals of the network & the output voltage V_{oc} (V_{th}) without load.
2. Connect the load at the output of the network & measure the current IL through the load.
3. Disconnect the voltage source & load, short the input terminals of the network & measures the thevenin's equivalent resistance at the output terminals.
4. Draw the thevenin equivalent circuits by connecting Rth in series with Vth.
5. Adjust the input voltage of the voltage source that equals

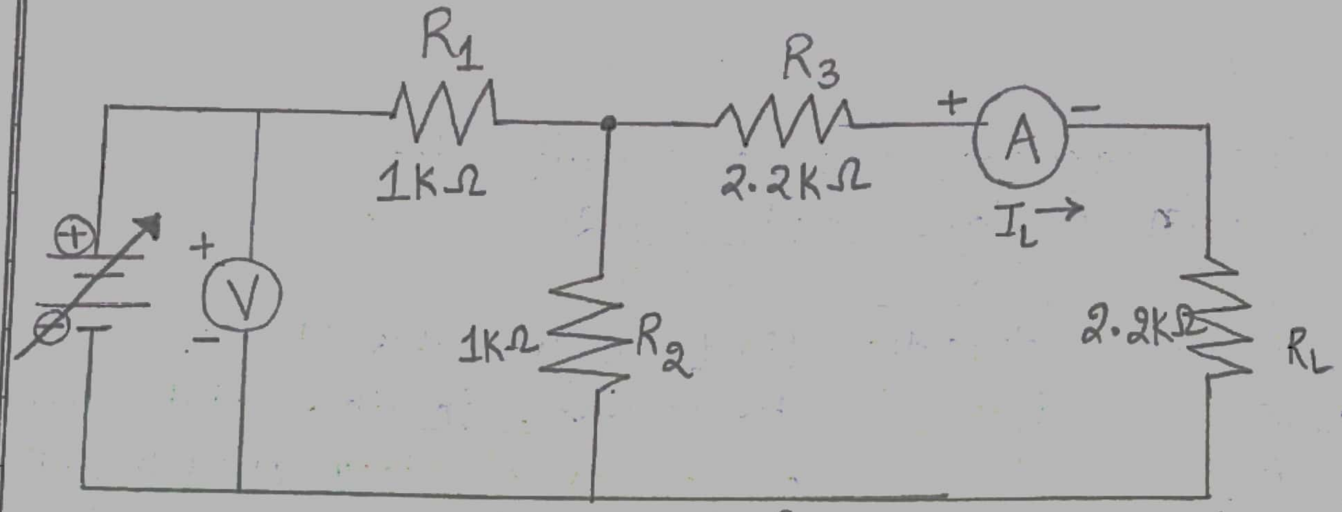


Fig 3-a Circuit is theveninised

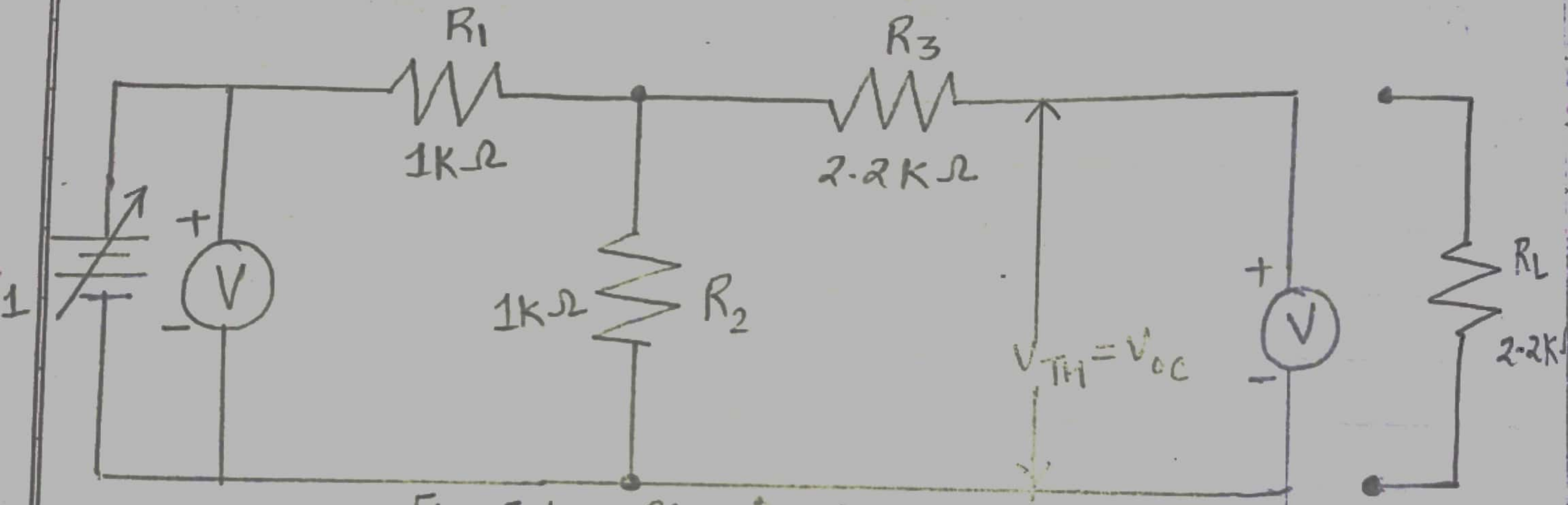
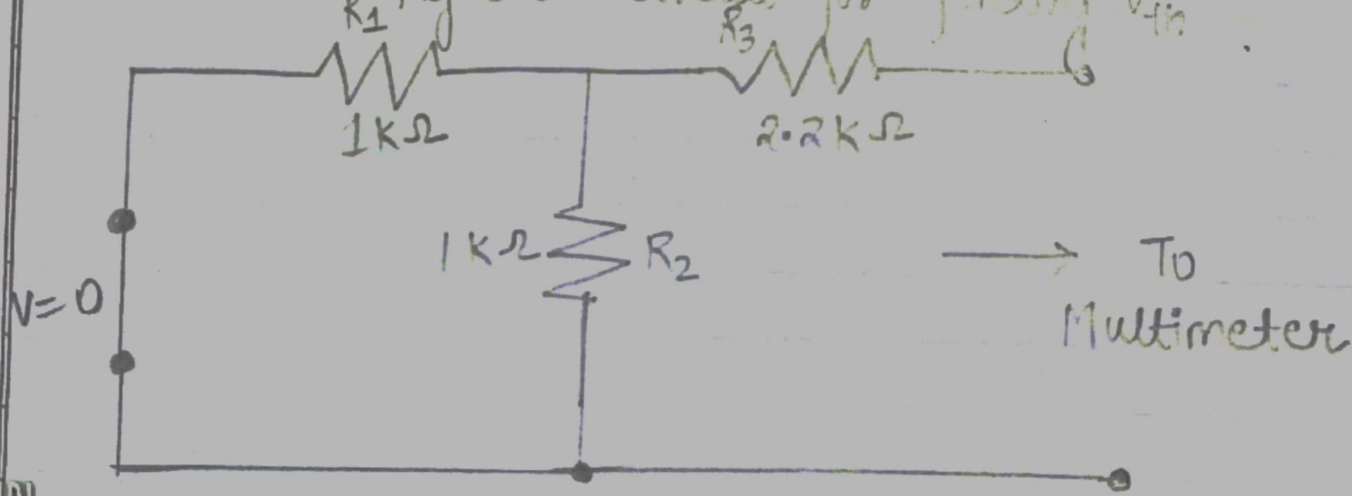


Fig 3-b Circuit for finding V_{th}



Circuit for finding R_{TH}

to thevenin's voltage & apply to input terminals of circuit
6. Measure I_L with connecting load at output terminals & compare with I_L. Thevenin theorem states that $I_L = I_L'$

PRECAUTIONS

1. Connect the circuit elements as per the circuit diagram
2. Avoid loose connections of the circuit elements
3. Take the readings carefully and accurately
4. Do not tamper the circuit elements.

OBSERVATIONS : Thevenin's Theorem

S.no	Input voltage (V)	V_{th} (V)	R_{th} (Ω)	R_L (Ω)	I_L (mA)	I_L' (mA)	Error $(I_L - I_L')$ (mA)

RESULT : Thevenin Theorem has been verified at different voltage sources & resistances & corresponding errors are found.

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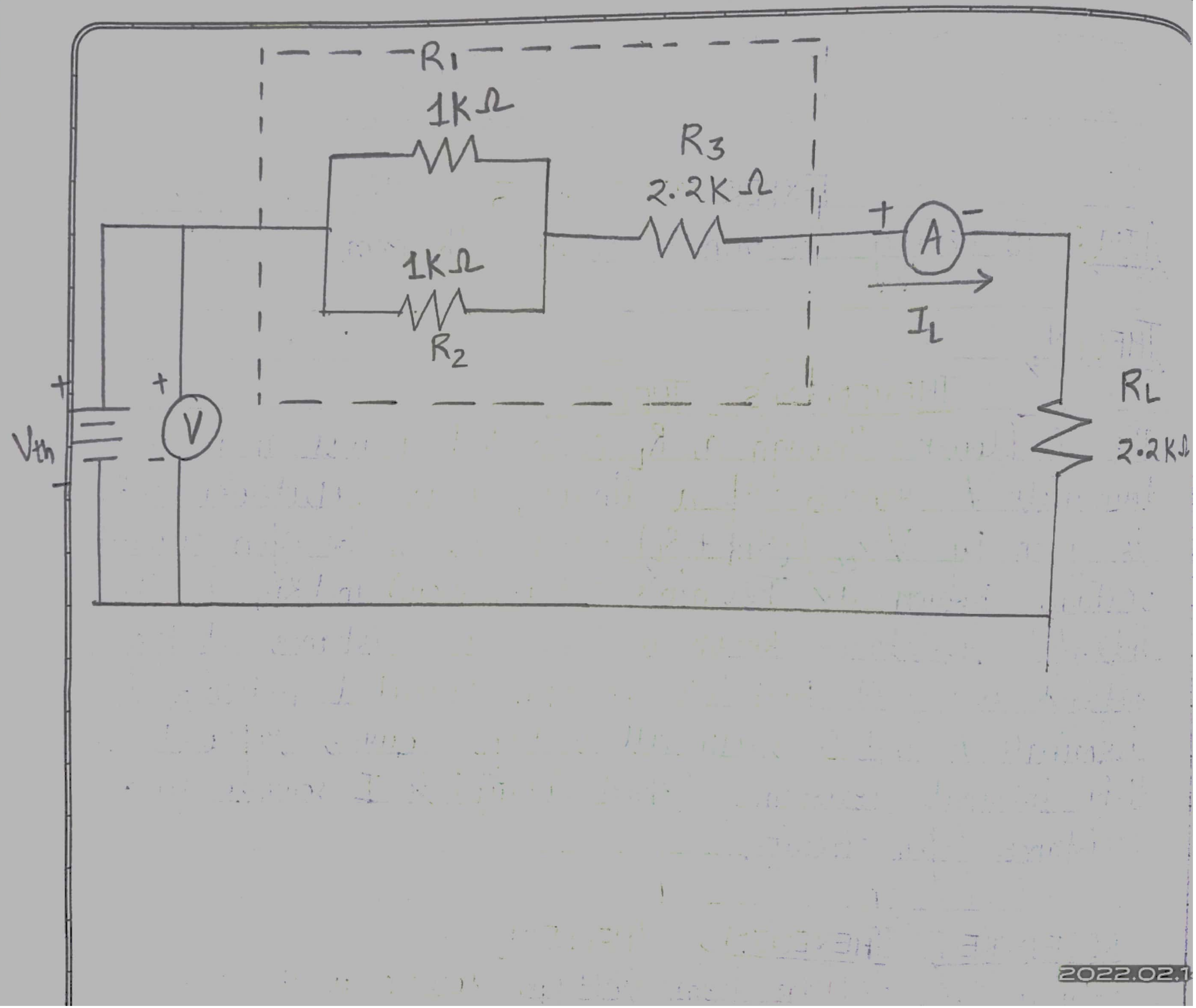
R1
1KΩ
R3
2.2KΩ
1KΩ
R2
A
IL
RL
2.2KΩ
Vth
V
2022.02.1

NORTON'S THEOREM,

Any 2 terminals active network containing voltage sources & resistances when viewed from its output terminals is equivalent to a constant current source and a || resistance. The $I_{constant} = I$ which would flow in a short circuit placed across the terminals and || Resistance is the resistance of network when viewed from these open circuits terminal after all voltage & current sources have been removed & replaced by their internal resistance

PROCEDURE: Norton's theorem

1. Apply DC voltage from voltage source to the input terminal of the network and measure the load current I_L at the output of the source.
2. Apply DC Voltage and measure short circuit I_{sc} by short circuiting load terminals.
3. Disconnecting the voltage sources & load, short the input terminals of the network & measure the Norton's equivalent impedance R_N at the output terminals.
4. Draw Norton's equivalent circuits by connecting R_N in || with I_{sc}
5. Measure the load current I_L' with connecting load at output terminals and compare with I_L.

Norton's theorem states that $I_L = I_L'$

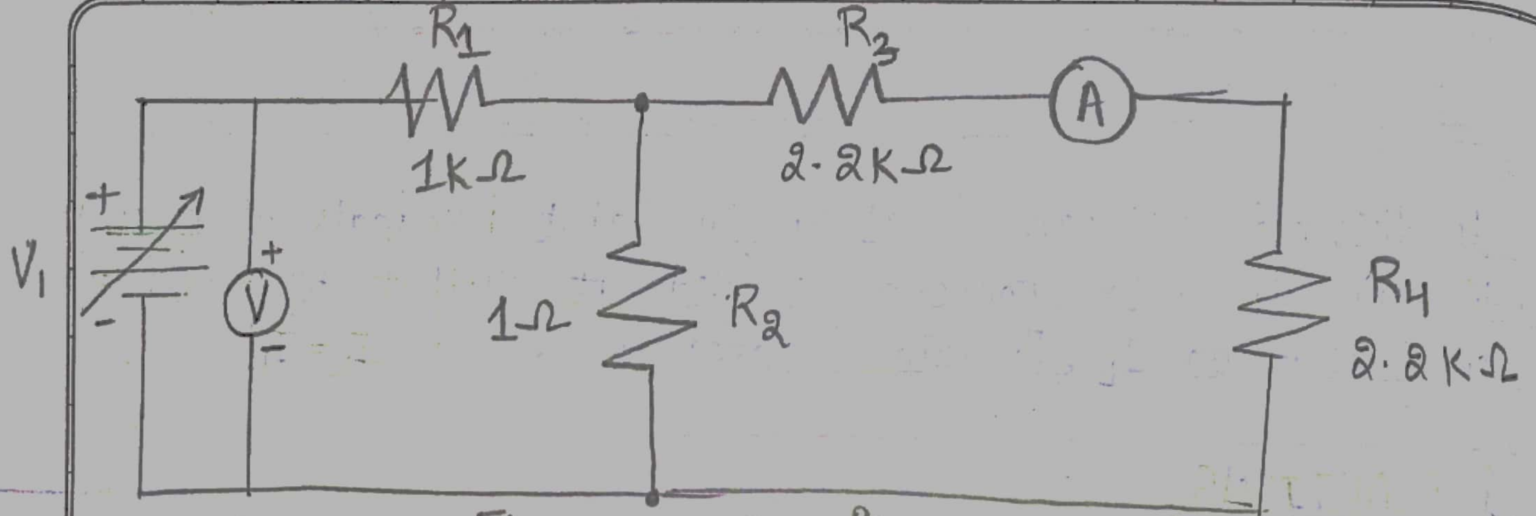

Fig 3-a Circuit to be Nortonize

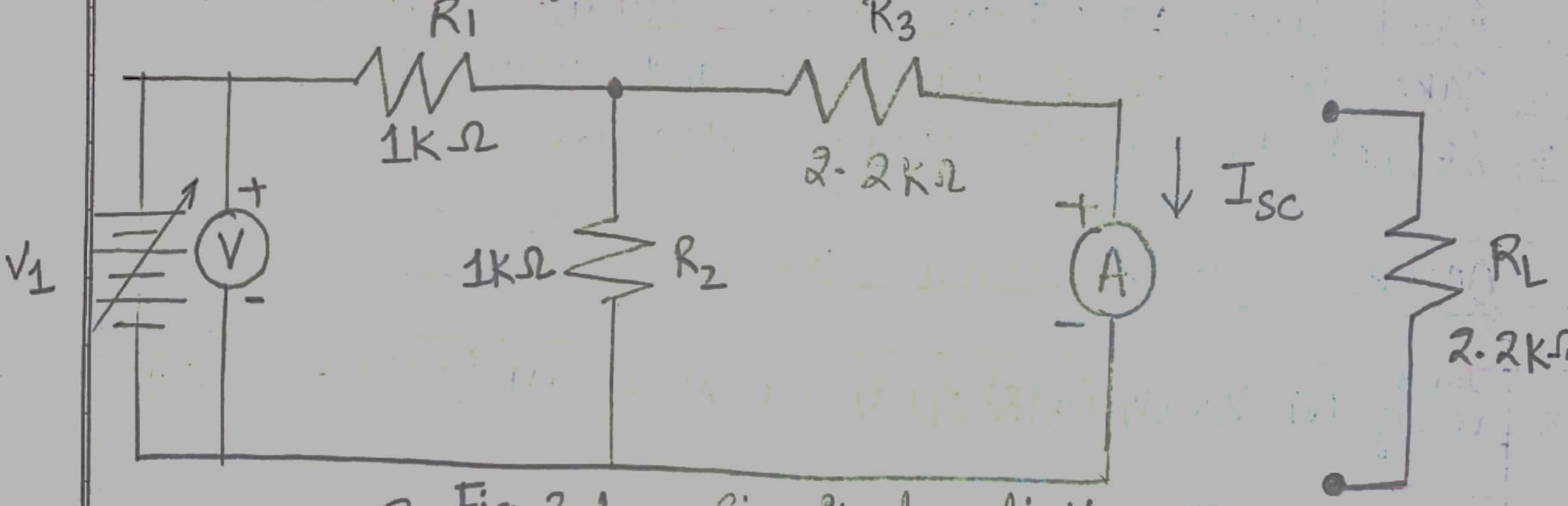

Fig 3-b Circuit for finding I_{sc}

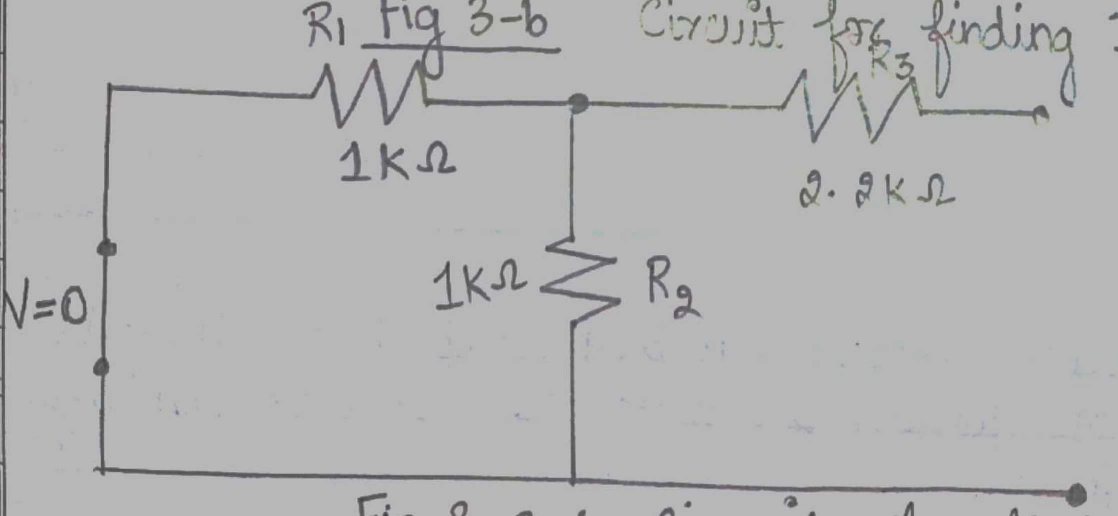

Fig 3-c : Circuit for finding R_N

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OBSERVATIONS:

NORTON'S THEOREM

S.no	Input (V) voltage	I_{SC} (mA)	R_N (Ω)	R_L (Ω)	I_L (mA)	I_L' (mA)	Error = ($I_L - I_L'$) (mA)
1							
2							
3							
4							
5							

RESULT: Norton's theorem has been verified for different current sources & resistances and corresponding errors are found.

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EXPERIMENT NO. : 4

AIM: To verify superposition theorem and reciprocity theorem.

THEORY: SUPERPOSITION THEOREM

If any linear, bilateral network contains more than one source, then the current flowing through any branch is the sum of all currents, which would flow through that branch if each source were considered separately, and all the other sources being killed or deactivated. Short circuiting it can kill a voltage source & open circuitting it can kill a current.

PROCEDURE:

1. Connect V_1 & V_2 as shown is fig I-a.
2. For different V_1 & V_2 values note the DC ammeter reading as "I_T"
3. Replace 'V_2' with a short circuit as shown in fig I-b & read the ammeter reading as "I_1" for corresponding values of V_1.
4. Replace "V_1" with a short circuit as shown in fig I-c & connect "V_2" in the circuit & read "I_2" for corresponding values of V_2
5. $I_T = I_1 + I_2$

PRECAUTIONS:

1. Connect the circuit elements as per the circuit diagram.
2. Avoid loose connections of the circuit elements.
3. Take the readings carefully & accurately.
4. Do not tamper the circuit elements.

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Circuit considered for verification of SPT

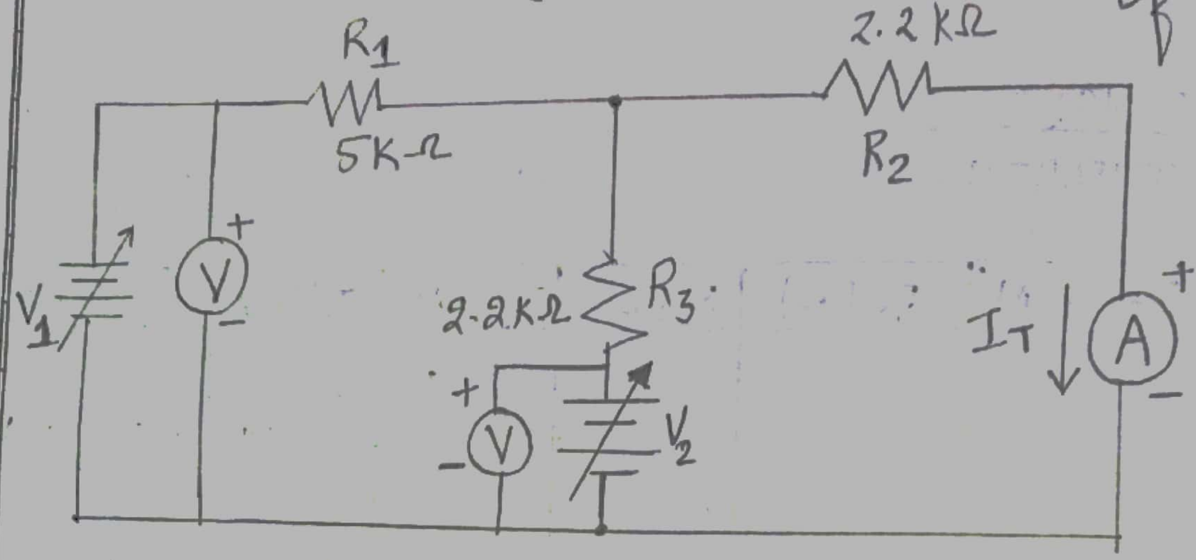
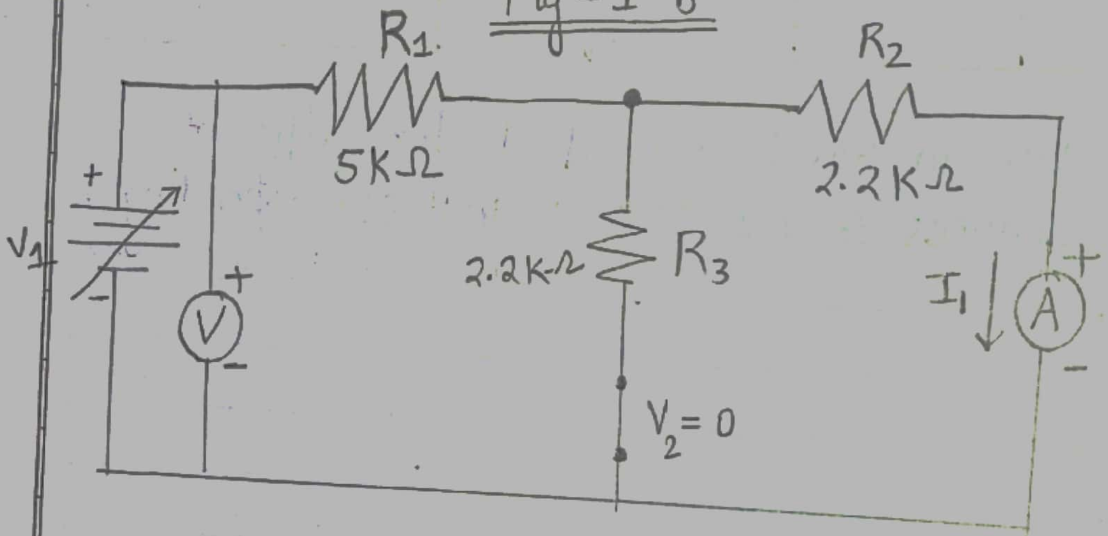
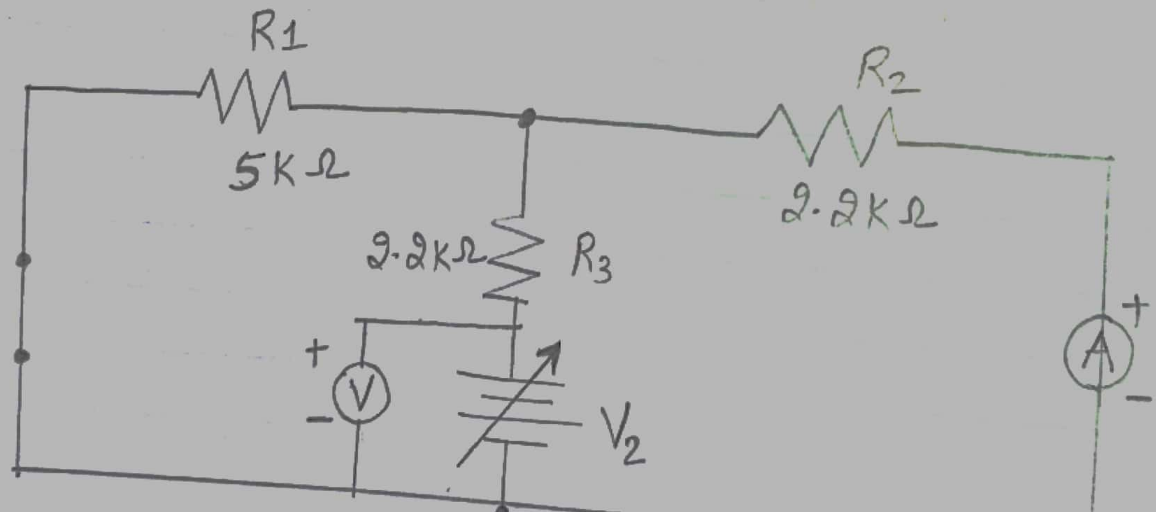


Fig I-a

Fig-I-b



Circuit with V1 only



Circuit with V2 only

Fig I-c

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RESULT:

Superposition theorem has been verified for different voltage sources & corresponding errors are found.

THEORY:

RECIPROCITY THEOREM

In any linear bilateral network, if a source of emf E in first branch produces a current I in second branch, then the same emf E acting in the second branch would produce the same current I first branch.

PROCEDURE:

1. Connect the circuit as shown in fig I-d.
2. Apply some voltage V.
3. Note down the ammeter readings as "I_1".
4. Interchange the ammeter & voltage source as shown in fig I-e and read the ammeter reading as "I_2".
5. Repeat the above procedure for different values or V and tabulate the values
6. I_1 should be equal to I_2.

PRECAUTIONS:

1. Connect the circuit elements as per the diagram.
2. Avoid loose connections of the circuit elements.
3. Take the readings carefully & accurately.

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OBSERVATION TABLE → Superposition Theorem

S.no	Input voltage		I_1 (mA)	I_2 (mA)	I_T (mA)	Error
	V_1 (volts)	V_2 (volts)				$I_T - (I_1 + I_2)$
1						
2						
3						
4						
5						

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4. Do not tamper the circuit elements

RESULT:

Reciprocity theorem has been verified for different voltage sources & corresponding errors are found.

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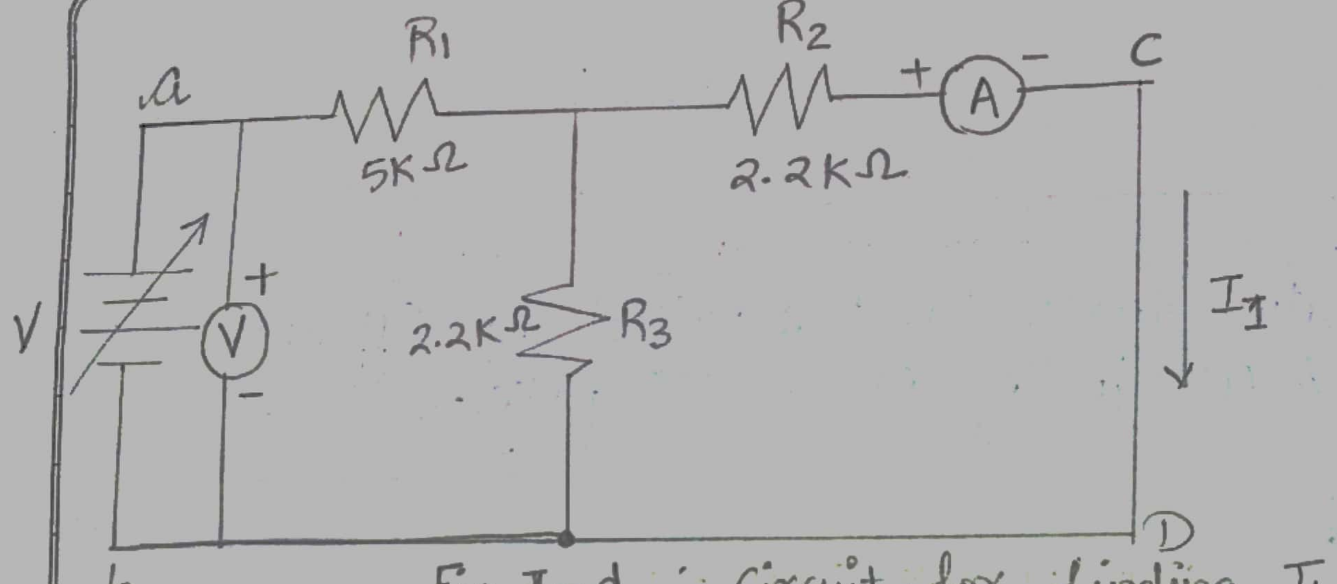

Fig I-d : Circuit for finding I_1

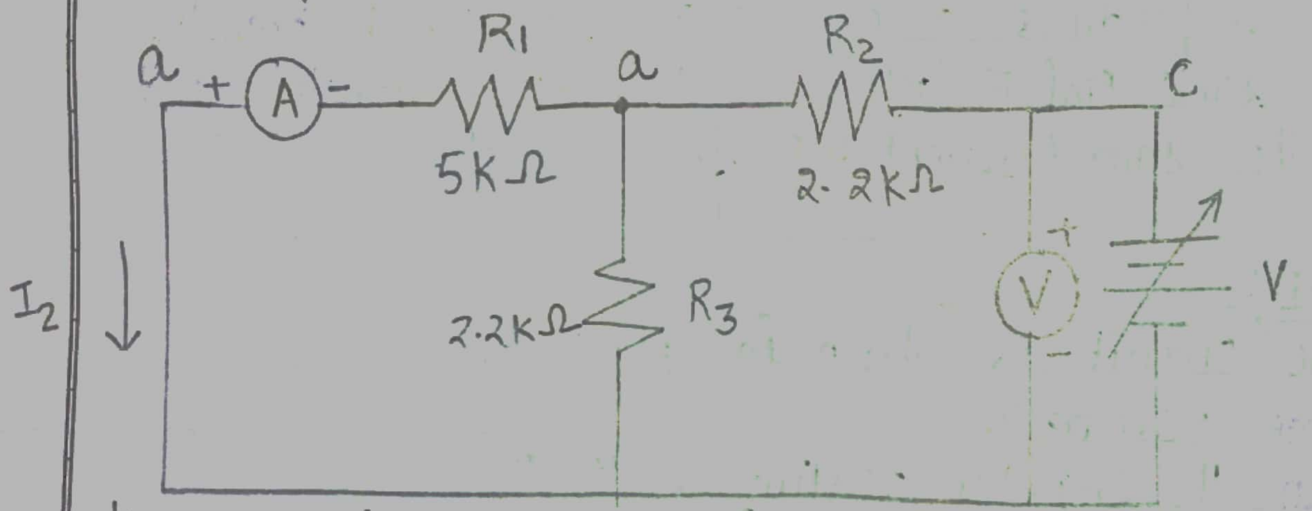

Fig I-d : Circuit for finding I_2

OBSERVATION TABLE : Reciprocity Theorem

S.no	Input voltage V (volts)	I_1 (mA)	I_2 (mA)	Error $(I_1 - I_2)$ mA

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EXPERIMENT NO. : 5

AIM: To verify maximum power transfer theory.

THEORY:

It states that in a D.C. Network maximum power is transfer from source to the load when the R_L = source resistance. The source resistance is the internal resistance of the network as viewed from the load terminals
The maximum power transferred when $R_S = R_L$ is

$$P_{max} = V^2 / R_L$$

PROCEDURE:

1. Connect the circuit as shown if fig 5-a.
2. Varying the load resistance in steps & note the ammeter readings & calculate power.
3. Plot the graph by taking resistance on x-axis and power on y-axis.
4. R_S should be equal to R_L for maximum power transfer.

PRECAUTIONS:

1. Connect the circuit elements as per the circuit diagram.
2. Avoid loose connections of the circuit elements.
3. Take the readings carefully & accurately.
4. Do not tamper the circuit elements

RESULT:

$$P = P_{max} \text{ when } R_S = R_L$$

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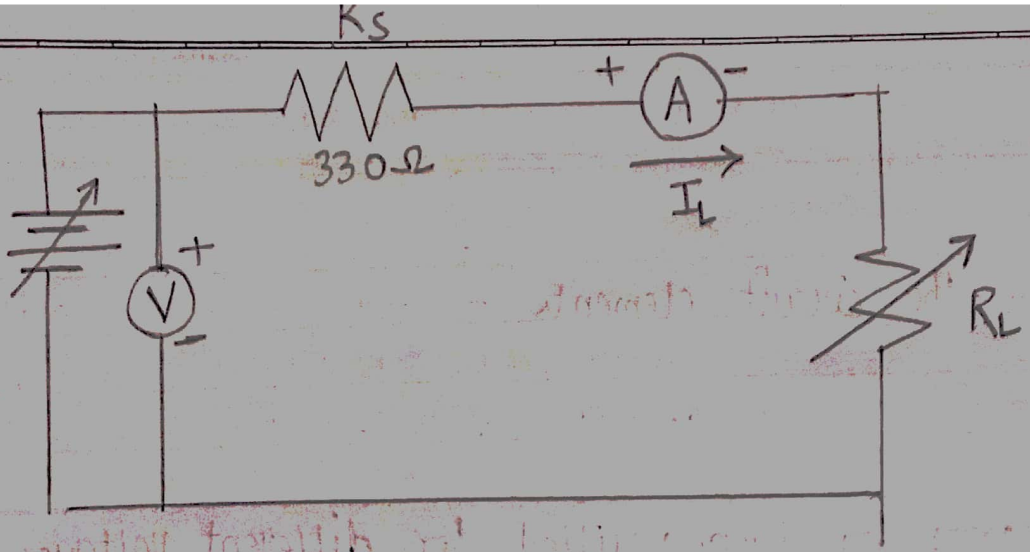
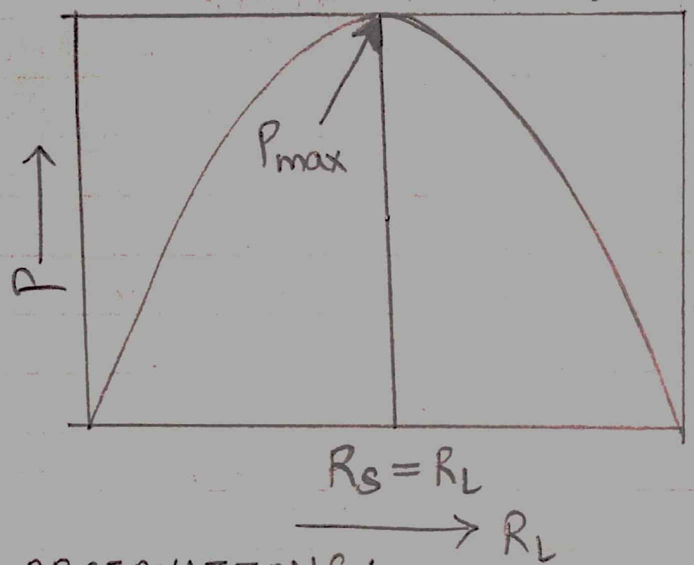




OBSERVATIONS:

S.no	Input voltage V (volts)	R_S (Ω) Series resistance	R_L (Ω/kΩ) Load resistance	I_L (mA) Load current	$P = I^2 R_L$ (mW) Load Power

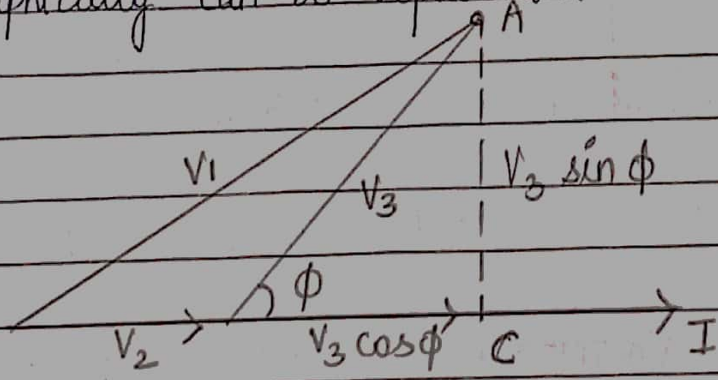
ELECTRICAL EXPERIMENT NO. : 6

AIM: To measure the power & power factor by 3 voltmeter and 3 ammeter method.

APPARATUS: AC Voltmeter, AC supply, Circuit Board, Connecting wires

THEORY: THREE VOLTMETER METHOD:

On analysing the given circuit it is observed that the two elements, resistor & inductor are connected in series i.e the same amount of current is passing through each element. The voltage drop in inductor is leading the current which is graphically can be represented as



PROCEDURE:

1. Give the connections as in the circuit diagram.
2. Apply 230 V, 1-ϕ AC voltage by means of 1-ϕ A varies to the series combination of choke coil & external resistance.
3. Note down the readings of the 3 voltmeters.
4. Apply different voltages in suitable steps and note down the readings of voltmeter.

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5. Calculate Power and Power Factor of coil using the formulae given below.

Now, from figure, Apply Pythagoras theorem on ΔABC

$$V_1^2 = (V_2 + V_3 \cos\phi)^2 + (V_3 \sin\phi)^2$$

$$V_1^2 = V_2^2 + 2V_2V_3\cos\phi + V_3^2\cos^2\phi + V_3^2\sin^2\phi$$

$$V_1^2 - V_2^2 - V_3^2 = 2V_2V_3\cos\phi$$

$$\cos\phi = (V_1^2 - V_2^2 - V_3^2) / 2V_2V_3 \quad \text{——} \quad (1)$$

For real Power :-

$$2V_2V_3\cos\phi = V_1^2 - V_2^2 - V_3^2$$

$$2(IR)V_3\cos\phi = V_1^2 - V_2^2 - V_3^2$$

$$V_3 I\cos\phi = (V_1^2 - V_2^2 - V_3^2) / 2R$$

$$\text{Real Power} = (V_1^2 - V_2^2 - V_3^2) / 2R \quad \text{——} \quad (2)$$

Sno	I	V_1	V_2	V_3	Power	Power Factor

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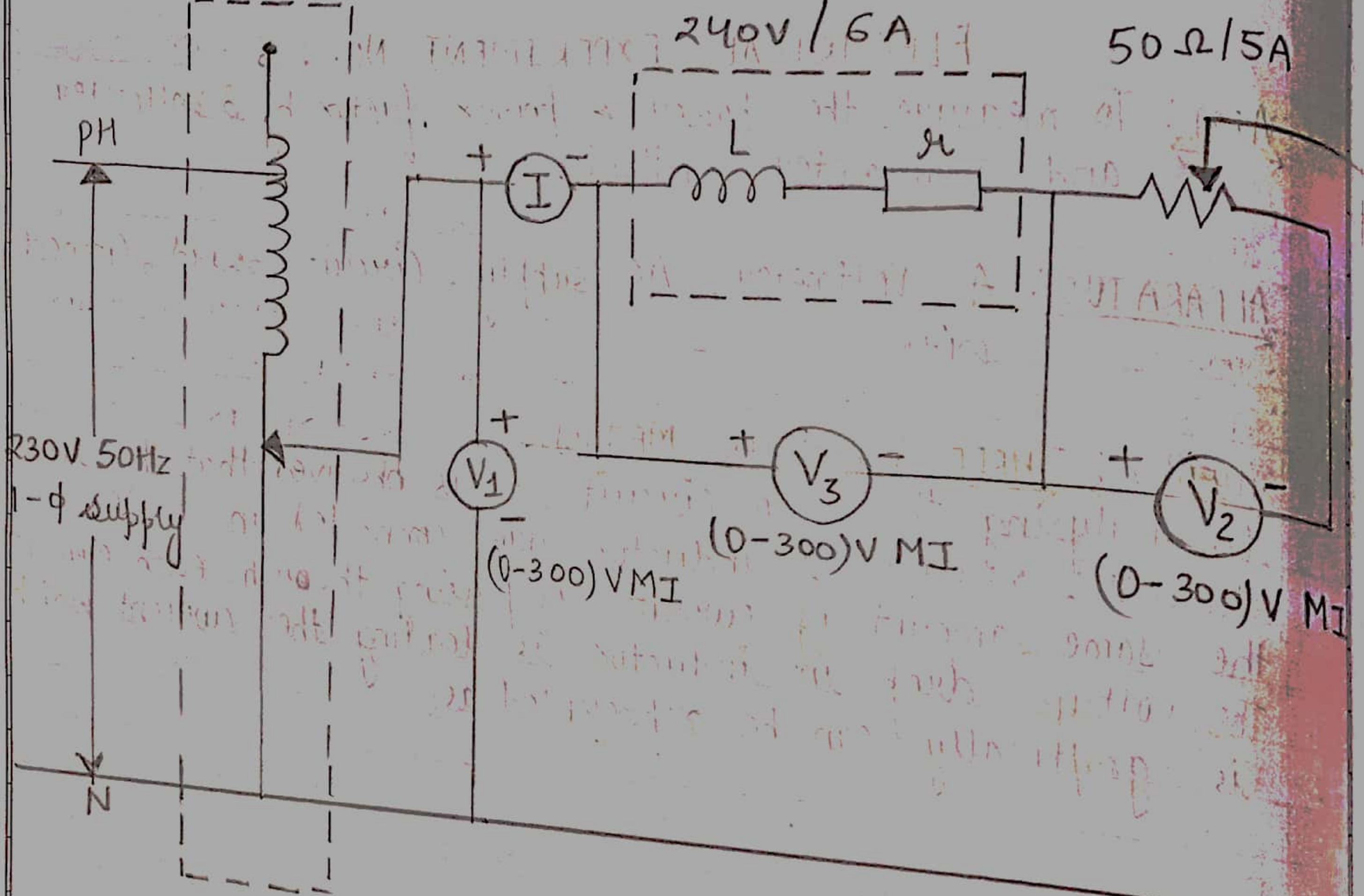
CIRCUIT DIAGRAM



THREE VOLTMETER METHOD

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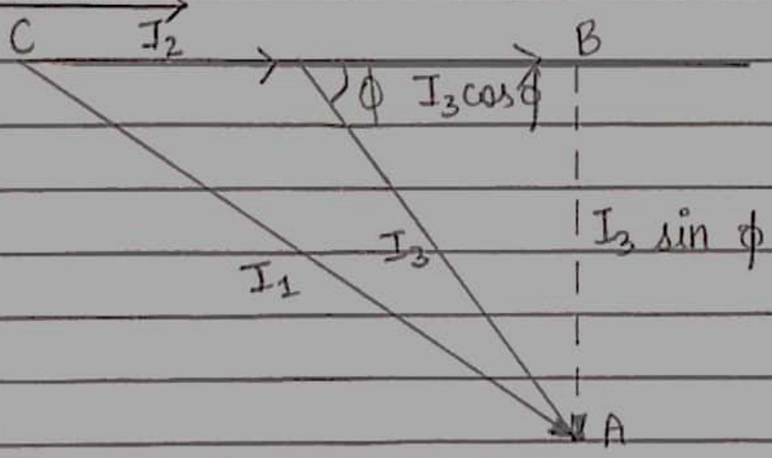
THEORY: THREE AMMETER METHOD

On analysing the given circuit, the total current I_1 is divided into I_2 & I_3. I_2 current is passing through resistor therefore it is in phase with applied voltage, while I_3 is passing through inductor therefore it is lagged by angle ϕ wrt applied voltage.

PHASOR DIAGRAM



PROCEDURE

1. Give the connections as in the circuit diagram.
2. Apply 230V, 1-ϕ AC voltage by means of 1-ϕ AC variac to the series combination of choke coil & external resistance.
3. Note down the readings of all the three ammeters.
4. Now vary the rheostat (50Ω/5A) so that I_1 varies in suitable steps.
5. At each step tabulate the reading of the three ammeters.
6. Calculate Power & Power Factor of coil using the formulae given below

Resolve I into components & consider ΔABC

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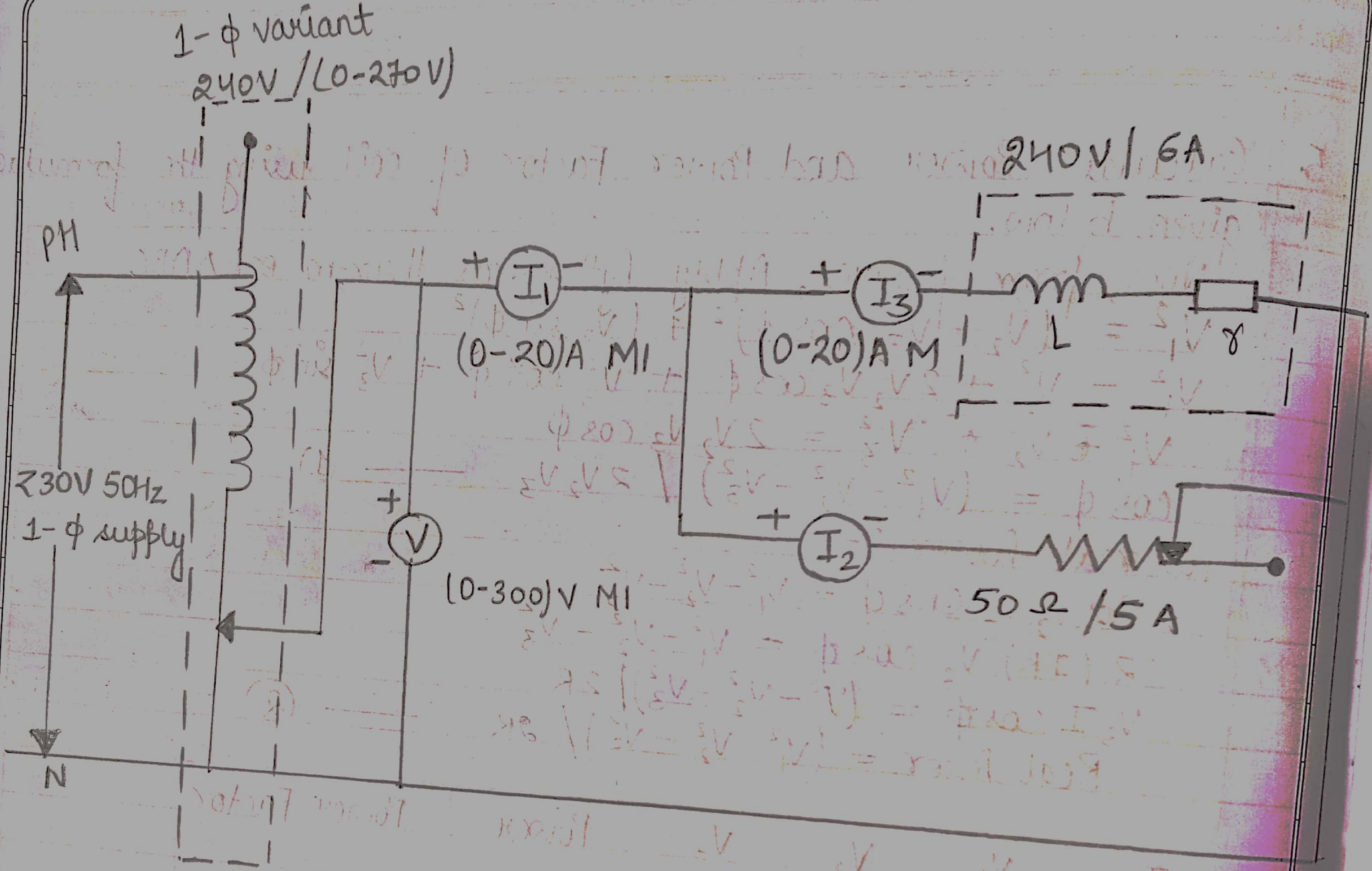

THREE AMMETER METHOD

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$$(I_1)^2 = (I_2 + I_3 \cos\phi)^2 + (I_3 \sin\phi)^2$$

$$I_1^2 = I_2^2 + I_3^2 \cos^2\phi + 2I_2I_3\cos\phi + I_3^2\sin^2\phi$$

$$I_1^2 = = I_2^2 + I_3^2 + 2I_2I_3\cos\phi$$

$$I_1^2 - I_2^2 - I_3^2 = 2I_2I_3\cos\phi$$

Now, $\cos\phi = (I_1^2 - I_2^2 - I_3^2) / 2I_2I_3$

Now, consider above equation again.

$$2I_2I_3\cos\phi = (I_1^2 - I_2^2 - I_3^2) \cancel{/2I_2I_3}$$

$$2(V/R)I_3\cos\phi = (I_1^2 - I_2^2 - I_3^2)$$

$$VI_3\cos\phi = (I_1^2 - I_2^2 - I_3^2)R/2$$

$$P = (I_1^2 - I_2^2 - I_3^2)R/2$$

$$\text{Real Power} = (I_1^2 - I_2^2 - I_3^2)R/2$$

S.no	V	I_1	I_2	I_3	P	$\cos\phi$

RESULT:

Power & Power factor of load (coil) for different AC voltage sources & load (coil) combination has been successfully calculated by three voltmeter & three ammeter method.

Teacher's Signature..............................

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