Experiment -1

Aim :- Familiarisation of equipments ~~&~~ and components used in the basic electrical science lab.

Equipment Required :- Resistor, Inductor, Capacitor, DC power supply, Digital storage oscilloscope (DSO), Bread Board, Function Generator, Multimeter.

Theory :-

(i) DC power supply :- A power supply is an electrical device that supplies electric power to an electrical load. The main purpose of supply is to convert electric current from AC to DC.

(ii) Function generator :- A function generator is electronic test equipment that generates standard waveforms. It can be used to test a design or confirm that a piece of electronic equipment is working as intended.

(iii) Multimeter :- A multimeter is measuring instrument the multiple electrical properties. A typical multimeter measures voltage, resistance, current and test for continuity.

(iv) Digital Storage Oscilloscope (DSO) :- An oscilliscope is a type of electronic test instrument that graphically displays varying electrical voltages as a two dimensional plot of one or more signals as a function of time.

Bread board :- A breadboard is a construction base used to build semi-permanent prototypes of electronic circuits.

Resistor :- A resistor is an electrical component that limits or regulates the flow of electrical current in a circuit.

Capacitor :- A capacitor is a device that stores electrical energy in an electric field by virtue of accumulating electric charges on two closed surface insulated from each other.

Resistance in series

$$R_{eq} = R_1 + R_2 + R_3 + \dots + R_n$$

Resistance in parallel

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n}$$

Observations

when the resistors are connected in series,

$$R_{eq} = R_1 + R_2$$

~~When the~~ $R_{eq} = (470 + 1000)\,\Omega$

$= 1470\,\Omega$

(We measure this resistance using a multimeter)

Multimeter reading = 1470 Ω

When the resistor are connected in parallel -

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{470} + \frac{1}{1000} \qquad \Rightarrow R_{eq} = \frac{470000}{1470} = 319.72\,\Omega$$

Multimeter reading = 520 Ω

Result

The experiment acquainted is with the basic electrical instruments used in the lab - multimeter, oscillioscope, function generator, DC source

Also, we verified the formula for equivalent resistance (both series and parallel).

Validation :-

The measured values are a little deviated from the theoretical values. This error is due to a computation error or due to error in measuring instruments. ~~Ideally~~, ~~F = F₁ + F₂~~

Date 12-09-2023

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Experiment - 2

AIM:-

To determine ohm's law.

EQUIPMENT REQUIRED:-

Three ~~to~~ resistance of 100Ω, 1 overall 470Ω or single resistance of 470Ω, wires, power source, multimeter and a bread board.

THEORY:-

The current through a conductor between two joints is directly proportional to voltage across two joints

$V \propto I$

$V = IR$ where V:- voltage
I:- current
R:- resistance

PROCEDURE:-

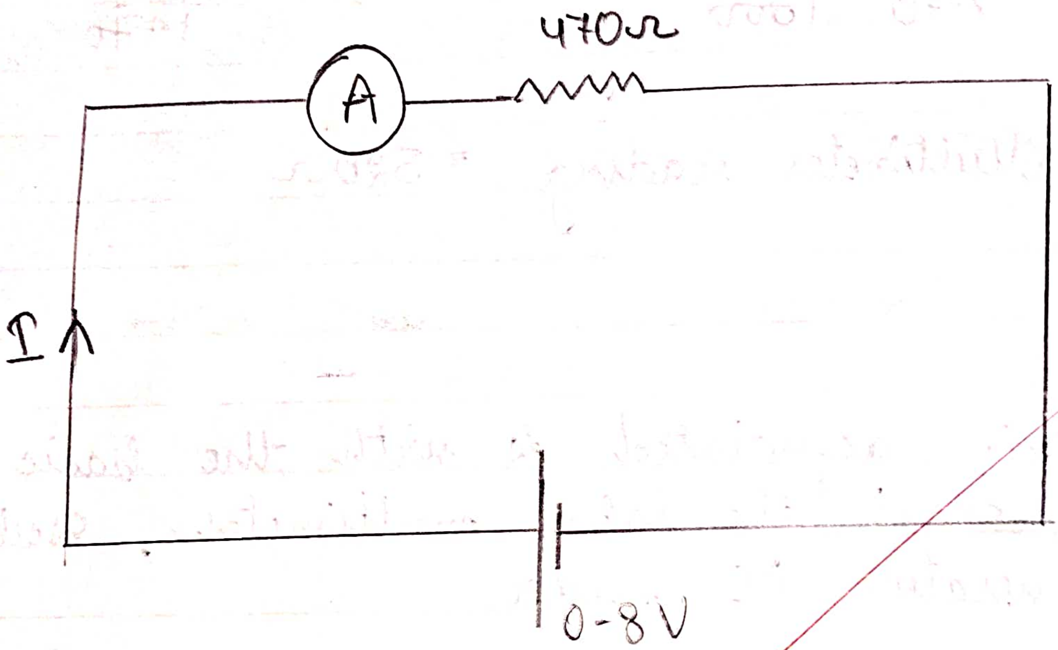
Connecting a resistor to a power supply and measuring the current in the resistor as the supply voltage is increased.

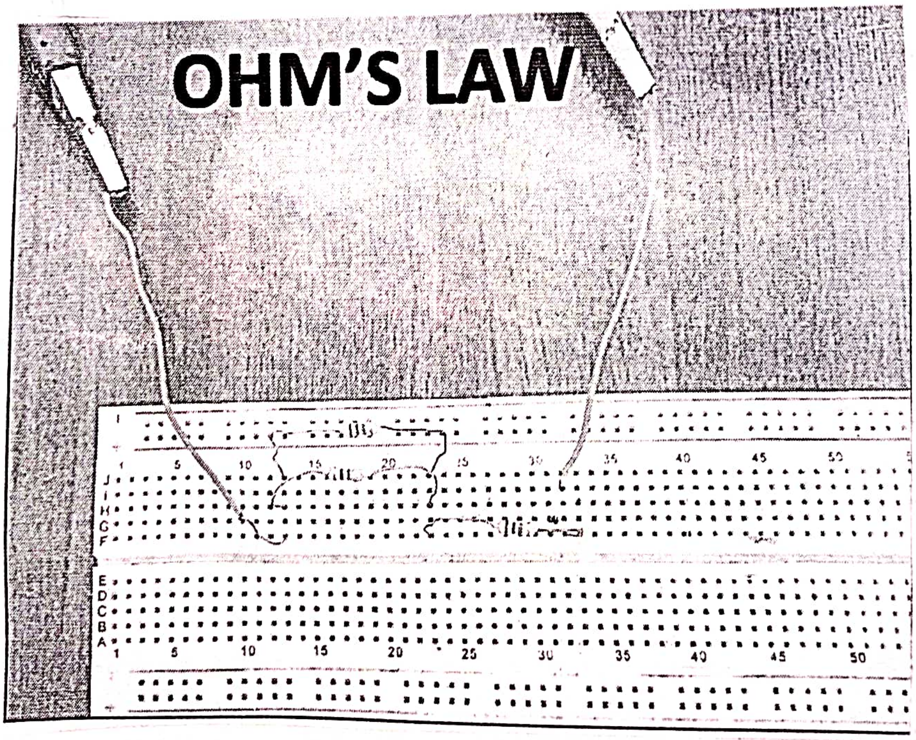
CALCULATION:-

$R_{eq} = 470\Omega$

Teacher's Signature

CIRCUIT DIAGRAM





OBSERVATION

Taking power supply voltage from 0-8V with increment of approximately 1-2 V.

S.No.	Voltage (in volt)	Current (in mA)
1.	2V	= ~~2/470~~ = 0.0042 = 4.2mA
2.	3.4V	= ~~3.4/470~~ = 7.2 mA
3.	5V	= ~~5/470~~ = 10 mA
4.	6V	= ~~6/470~~ = 12mA
5.	8V	= ~~8/470~~ = 16mA

RESULT :-

Value of resistance from calculation = 470 Ω

Value of resistance from graph =

PRECAUTIONS:-

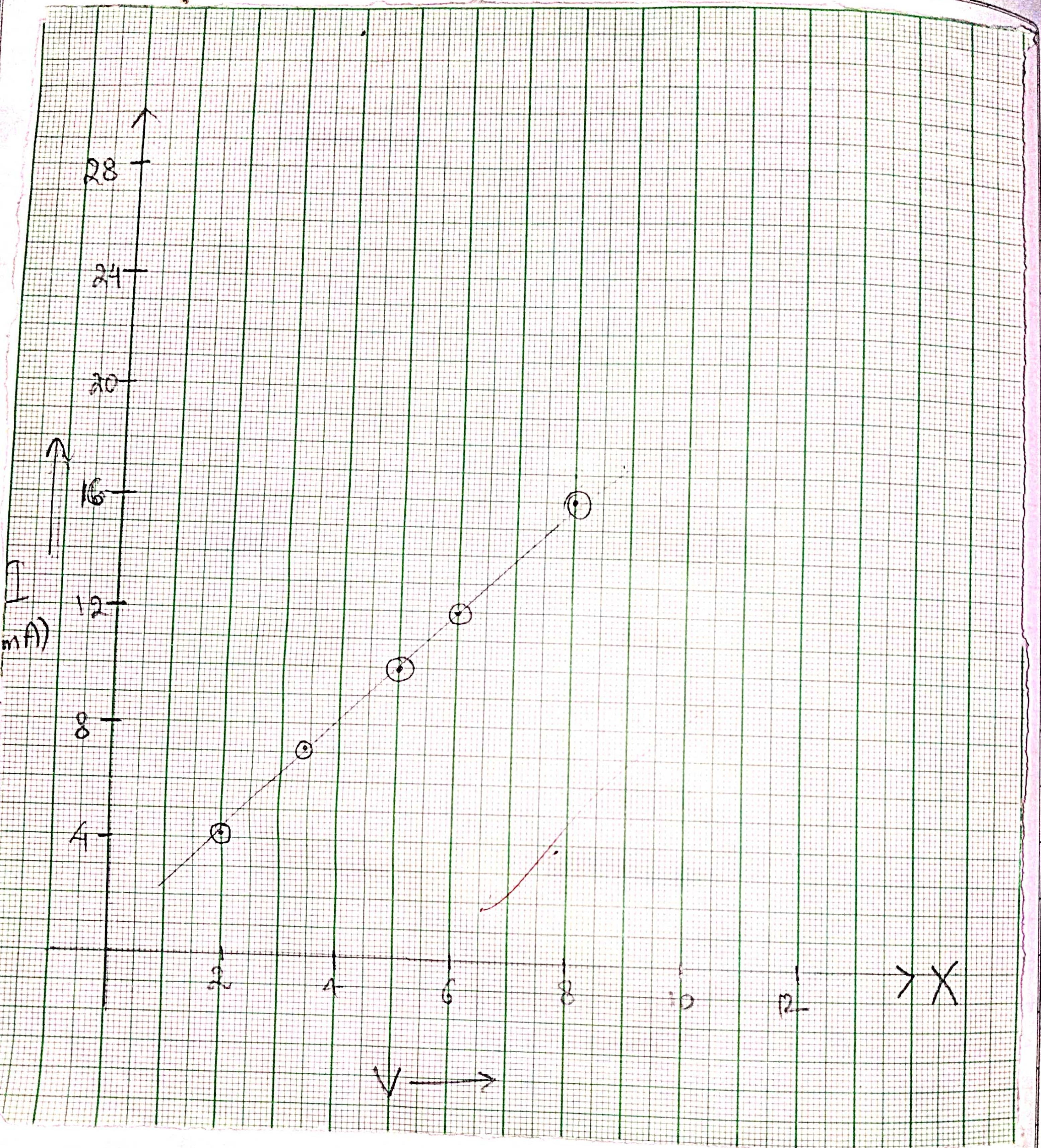
(i) Check for proper connection before switching ON the supply.

(ii) The terminals of the resistances should be properly connected.

Validation

The measured values are a little deviated from the theoretical values. This error is due to a computation error or due to error in measuring instruments.

Teacher's Signature ____________



$$\frac{1}{R} = \frac{I}{V} = \frac{(10 - 4.2) \times 10^{-3}}{5 - 2} = 1.93 \times 10^{-3}$$

Experiment-3

Aim :-
To verify Kirchoff's current law using a parallel circuit.

Equipments :-
DC power source, multimeter, bread board, resistors, wires

Theory :-
Kirchoff's Current law states that at any junction the total current entering the junction is equal to the current leaving the junction.

No amount of current is lost or stored in any part.

$$\sum_{k=1}^{n} i = 0$$

Kirchoff's Current law is based on conservative of charge.

Procedure

- Connect a wire to +ve end of DC source and the other end be free. Keep one end of another wire free and insert the other end in a slot of the bread board (slot A).

- Insert one end of both resistors in the some slot (slot A).
Insert the other end of both in another slot (slot B).

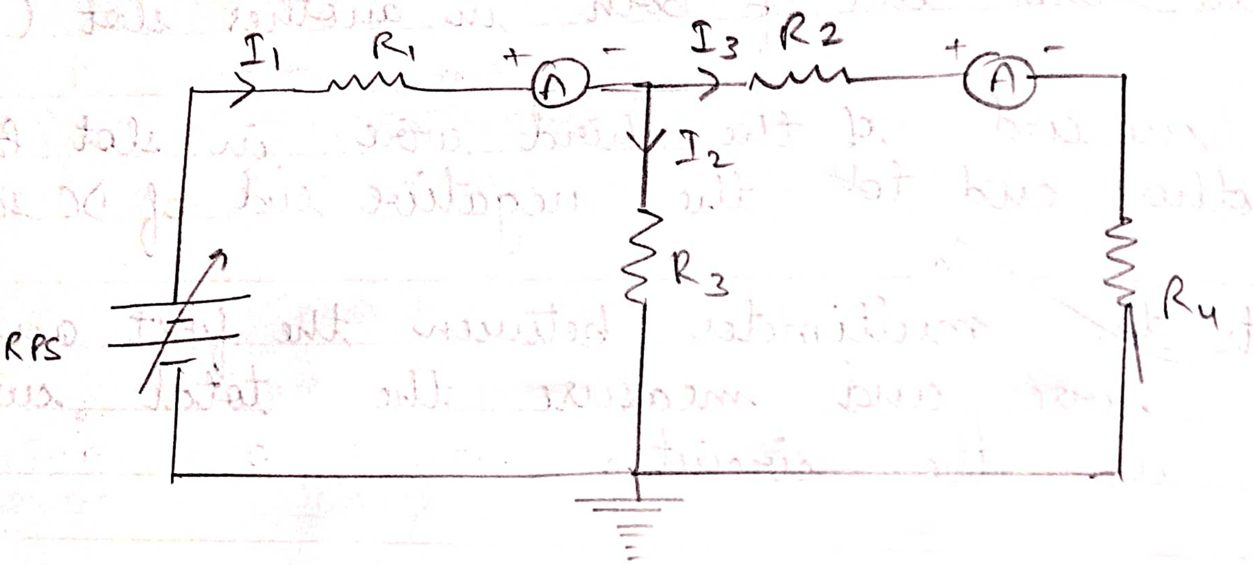
- Insert one end of the third wire in slot B and the other end to the negative end of DC source.

- Connect the multimeter between the first and second wires and measure the total current flowing in the circuit.

- Next measure the currents flowing through each resistor by connecting the multimeter in series with the resistor (in the respective parallel ~~for~~ arm of the resistor.

Observation

SNo	Voltage source	Total current (mA) (or current in R_1)	current in R_2	current in R_3
1.	5V	5	3.2	1.8
2.	10V	10	6.34	3.66
3.	15V	15	7.8	7.2



where $R_1 = 1k\Omega$

$R_2 = 470\Omega$

$R_3 = 4.7k\Omega$

$R_4 = 2.2k\Omega$

Calculations

1) $3.2 + 1.8 = 5$ By KCL, Σ incoming current $= \Sigma$ outgoing current

2) $6.34 + 3.66 = 10$

3) $7.8 + 7.2 = 15$

Result

Sum of current in parallel branches add upto the total current in circuit. No current is lost or stored, hence KCL is verified.

Precautions

1) All connection should be tight.
2) All steps should be followed carefully.
3) Reading and calculations should be taken carefully.
4) Don't touch live terminal.

Validation :-

The measured values are a little deviated from the theoretical values. This error is due to a computation ~~#~~ error or due to error in measuring instruments.

Experiment - 4

Aim:- To verify Kirchoff's voltage law using a series circuit.

Equipments :- DC power source, Multimeter

Components :- Bread board, resistor wires

Theory :-

Kirchoff's voltage law states that in a closed loop the sum of the emf's is equivalent to the sum of the potential drops.

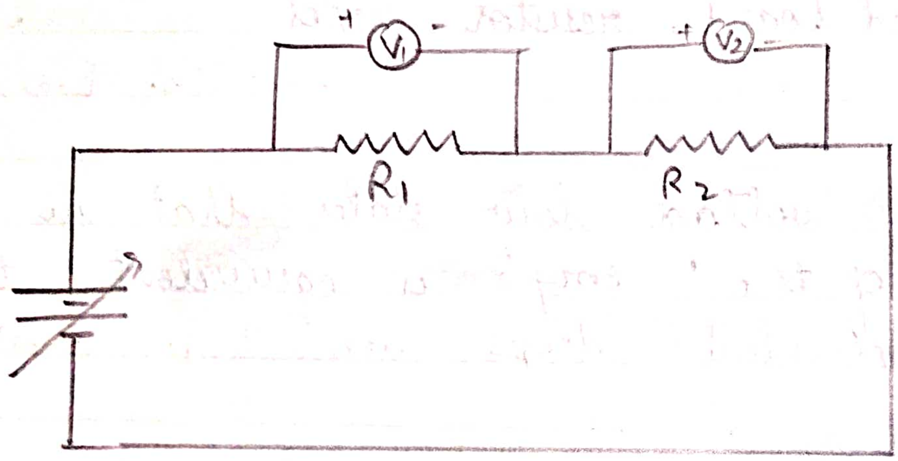
$$\sum_{k=1}^{n} V_k = 0$$

→ V_K represents any potential drop/ increase
→ n is the total number of voltages measured

The Kirchoff's voltage law is based on conservation of energy.

Procedure :-

- Connect a wire to the positive end of the DC source. Insert the other end of the wire in a slot of bread board.
- Insert one end of one of the resistors in the same slot.



where,

$R_1 = 1k\Omega = 1000\,\Omega$

$R_2 = 2.2k\Omega$

- Insert the other end of the resistors in another slot. Insert one end of another resistor in the same slot
- Insert the other end of resistor in another slot.
- Insert a wire in the same slot and then connect the other end to the negative side of DC source. Check the circuit as shown in circuit diagram.
- Set the multimeter to measure voltage and then connect the two ends of multimeter to the two ends of resistance to measure the potential drop.
- Also measure the potential of DC source.

Observation

S.No.	Voltage Source Potential	Potential drop against $R_1 = 1000\Omega$	Potential drop across $R_2 = \cancel{470\Omega}$ 2.2 kΩ
1.)	5V	1.603	3.528
2.)	10V	3.175	6.96
3.)	15V	4.748	10.41
4.)	20V	6.29	13.80

Calculations :-

Potential Gain ≥ Potential Drop (measured in resistors)

1.) $5.131 = (1.603 + 3.528)V$

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2.) $10.135 = (3.175 + 6.96)\ V$

3.) $15.158 = (4.748 + 10.41)\ V$

4.) $20.09 = (6.29 + 13.80)\ V$

Result

The potential drops against all the resistors add up to the total potential of the sources (voltage gains).

Hence, Kirchoff's loop law is verified.

Precautions

- Check for proper connection before switching ON the supply.
- The terminal of resistance should be properly connected.
- Do not alter the circuit keeping the DC source switched on switch OFF the DC source and then alter the circuit as required.

Validation :-

The measured values are a little deviated from the theoretical values. This error is due to a computation error or due to error in measuring instruments.

Teacher's Signature

Experiment - 5

Aim :- To verify superposition theorem.

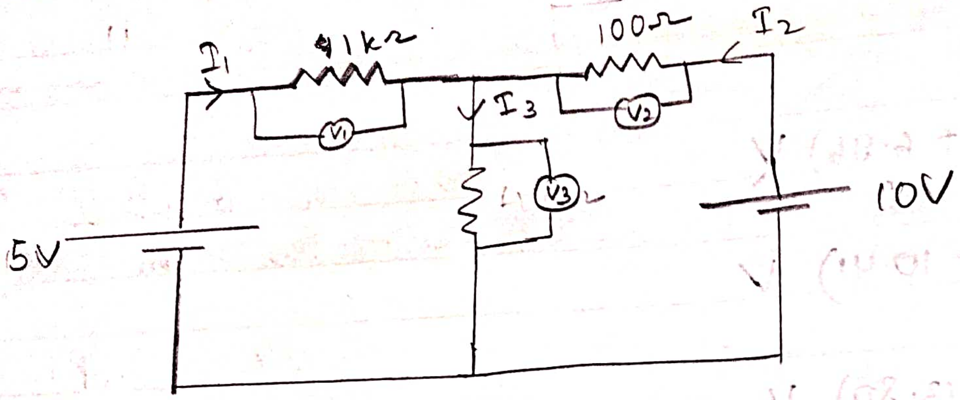
Equipments required :- Power supply, wires, resistances, 470Ω, 100Ω, 1kΩ, multimeter.

Theory :-
In any lateral or bilateral network or circuit having multiple independent sources the response of an element will be equal to algebraic sum of responses of that element by considering one source at a time.

Procedure :-
Connect the circuit. Take 5V first and check voltage drops in resistance again withdraw 5V and join 10V and check voltage drop across all resistances. At last join 10V and 5V both and check voltage drop across all resistances.

Observation

	V_1	V_2	V_3
From fig (ii) →	4.569V	0.39	0.39
From fig (iii) →	7.7	7.7	~~1.53~~ 2.4



Fig(i)

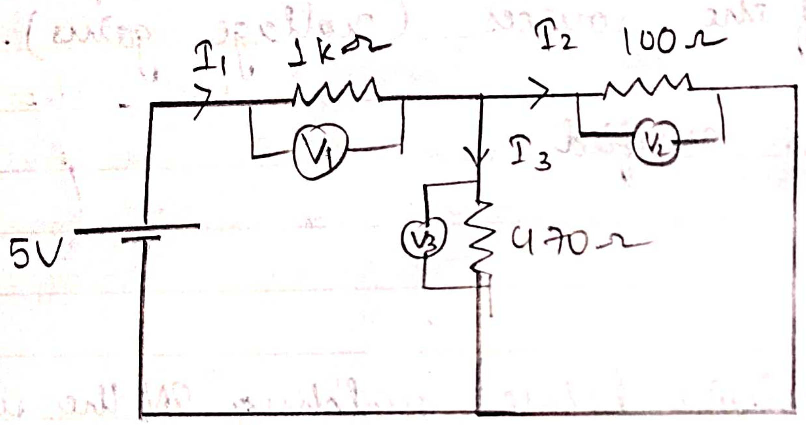


Fig ii

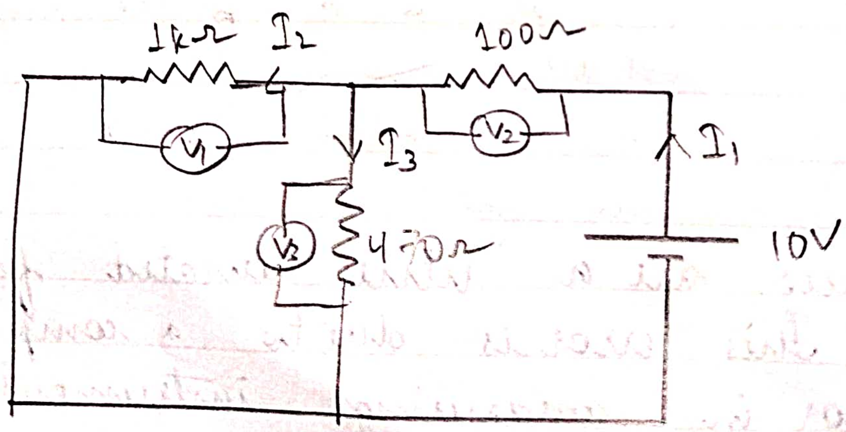


Fig iii

Calculation:-

For fig (ii) $\rightarrow$ $\cancel{V_1+V_2+V_3}$ V_1+V_2 = 5.349V

For fig (iii) $\rightarrow$ $\cancel{V_1+}V_2+V_3$ = 10.1V

Result:-

Voltage in fig (ii) theoretically = 5V and practically = 5.349V

Voltage in fig (iii) theoretically = 10V and practically = 10.1V

Precautions :-

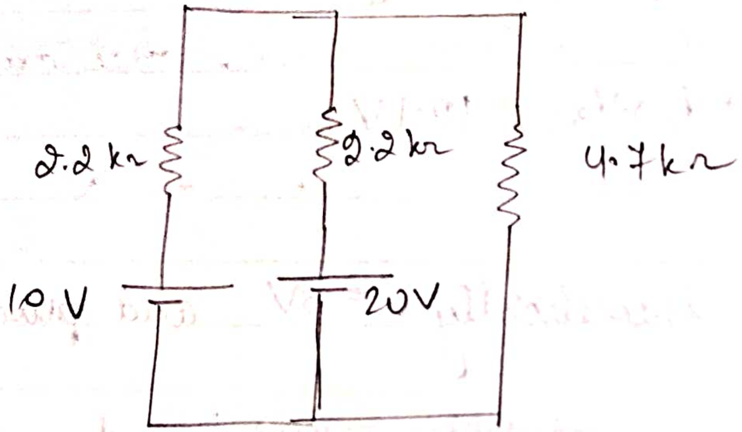
1.) Check for proper connections before switching ON the supply.

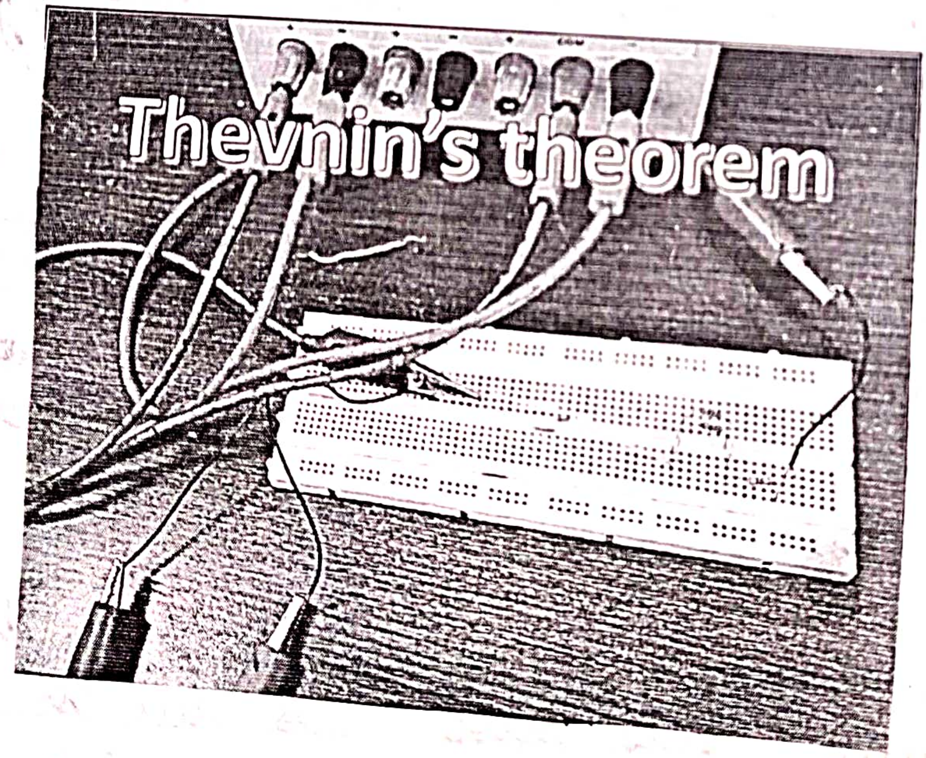
2.) The terminals of the resistances should be properly connected.

3) Do not alter the circuit keeping the DC source switched ON, switch OFF the DC source and then alter the circuit as required.

Validation:-

The measured values are a little deviated from the theoretical values. This error is due to a computation error or due to error in measuring instruments.


2.2 kΩ
2.2 kΩ
4.7 kΩ
10 V
20 V


Thevnin's theorem

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Experiment - 6

Aim:- To verify thevenin's theorem

Equipments required:-
Power supply, bread board, resistances
connecting wires

Theory:-
Any linear bilateral circuit can be replaced by an equivalent circuit consisting of a voltage source (V_{TH}) in series with a resistance (R_{Th}).
where,

V_{Th} = open circuit voltage at load terminals

R_{Th} = Equivalent resistance at load terminals where sources are short circuited.

Observation

	V_{Th}	V_{R_L}	R_{Th}	I_L
Ideal data	15 V	12 ~~7~~.126 V	1.1 kΩ	2.58 mA
Experimental data	15.	12.28 V	1.08 kΩ	2.71 mA

Teacher's Signature

for R_{th}

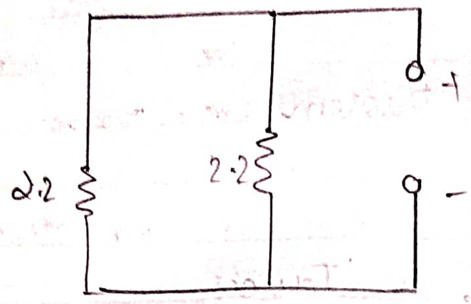
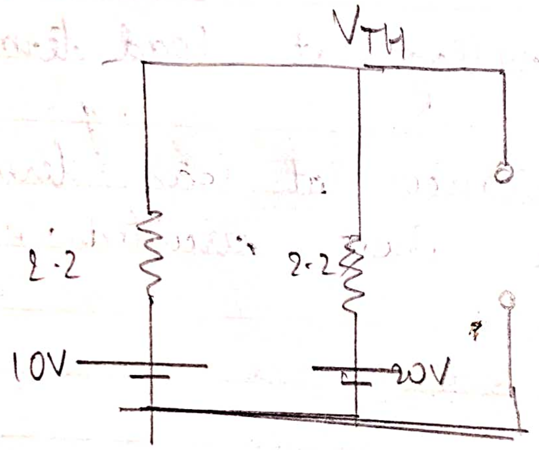
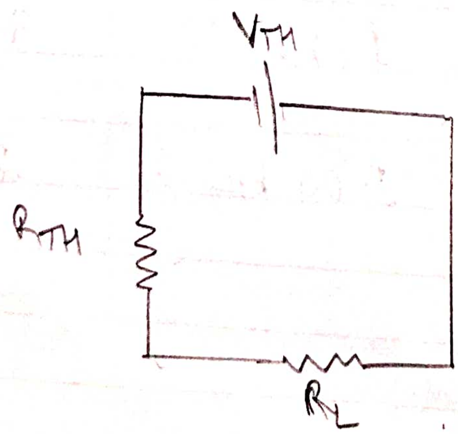


fig-1

for V_{Th}





Calculations :-

$$R_{TH} = \frac{2.2}{2} = 1.1\,k\Omega \quad \text{(from fig-1)}$$

By KCL, $\frac{V_{TH} - 10}{2.2} + \frac{V_{TH} - 20}{2.2} = 0$

$$V_{TH} = 15V$$

Result $I_L = \frac{15}{4.7 + 1.1} = \frac{15}{5.8\,k\Omega} = 2.58\,mA$

$$V_L = 2.58 \times 4.7 = 12.126\,V$$

Result

The calculated $V_L \approx$ the experimental V_L i.e. 12.126 and 12.28 V respectively.

Precautions :-

- Check for proper connections before switching ON the supply.
- The terminals of the resistances should be properly connected.
- Do not alter the circuit keeping the DC source switched ON switch Off the DC source and then alter the circuit as required.

Validation:-

The measured values are a little deviated from the theoretical values. This error is due to compilation error or due to error in measuring instruments.

Teacher's Signature

Date 26/10/23

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Experiment - 7

Aim :-

To verify maximum power theorem.

Components :-

RPS, multimeter, bread board, wires, resistors of 1 kΩ, 2.2 kΩ, 3.3 kΩ, 4.7 kΩ, 10 kΩ.

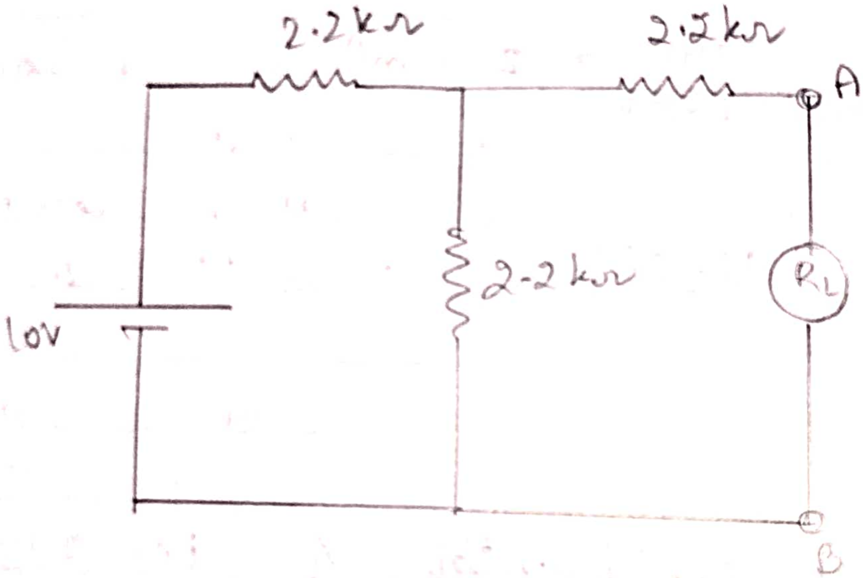
Theory :-

Maximum power transfer theorem explains that to generate maximum external power through the load with a finite internal resistance (DC source). The resistance of the given load should be equivalent to Thevenin's resistance.

Procedure :-

1. Connect the circuit as shown in figure.
2. Connect three 2.2 kΩ resistor in T-junction format
3. Add 10V connection to the circuit and add 3.3 kΩ of load
4. Remove the 3.3 kΩ and short the circuit.
5. Measure R_{Th} across load.
6. Keep checking power generated across load by adding and replacing different resistors by measuring voltage drop across it.
7. Calculate power by $P = \frac{V^2}{R}$
8. Note down atleast 4 to 5 recording.
9. Plot the graph and cross verify.

Teacher's Signature



Circuit Diagram

Observation Table

	Voltage (V)	R_{Th} (kΩ)	R_L (kΩ)	V_L (V)	$P = V^2/R$
1)	10V	3.32 kΩ	1	1.2	1.44
2)	10V	3.32 kΩ	2.2	2.05	1.21
3)	10V	3.32 kΩ	3.3	2.57	2.01
4)	10V	3.32 kΩ	4.7	3.02	1.94
5)	10V	3.32 kΩ	10	3.80	1.44

Calculation :-

$P_1 = \frac{V_1^2}{R_1} = \frac{(1.2)^2}{1} = 1.44\,mW$, $P_2 = \frac{V_2^2}{R_2} = \frac{(2.05)^2}{2.2} = 1.21\,mW$

$P_3 = \frac{V_3^2}{R_3} = \frac{2.57^2}{3.3} = 2.01\,mW$, $P_4 = \frac{3.02^2}{4.7} = 1.94\,mW$

$P_5 = \frac{3.80^2}{10} = 1.44\,mW$

Conclusion

We can see P output is maximum when load resistance is almost or equal to R_{Th}. Hence, verified.

Precaution

1. Check for proper connections before switching on the supply.
2. The terminals of the resistors should be properly connected.

Teacher's Signature

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3.) Do not alter the circuit while keeping the DC source on. Switch off the DC source & then alter the circuit as required.

Validation

The measured values are little bit deviated from the theoretical values due to error in computation of measuring devices or tiny resistance of wires.

Teacher's Signature ______

Date

Expt. No.

Experiment -8

Aim: To verify Norton's theorem.

Components: Multimeter, RPS, Breadboard, wires, resistors (1kΩ, 2.2kΩ, 2.2kΩ, 3.3kΩ)

Theory: Norton's theorem states that any complex linear circuit can be simplified to an equivalent simple circuit with a single current source in parallel with a single resistor connected to a load.

Procedure:

1.) Connect the circuit as shown in the diagram.

2.) Set voltage to 5V.

3.) Remove the load resistor and calculate Norton current.

4.) Replace voltage source with short circuit and current sources with open circuits and calculate the Norton resistance.

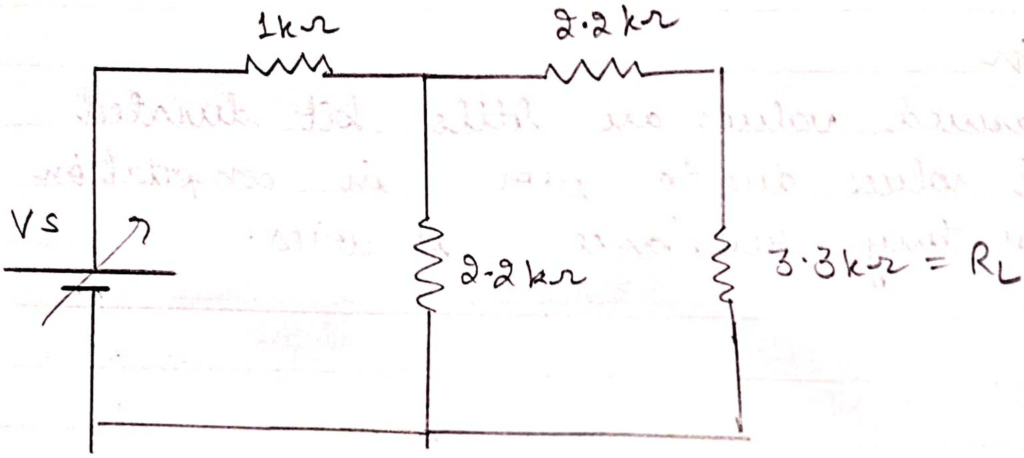
5.) Make connections for equivalent circuit, with Norton current source in parallel with Norton resistance and as well as with load resistor.

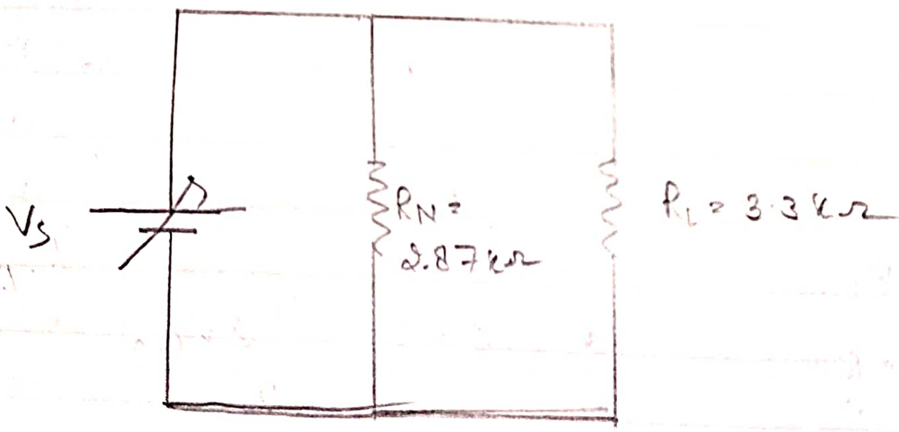
6.) Analyse voltage and current for the load current resistance.

7.) Here, find voltage across load resistance in both circuits, if they are same then Norton's theorem is verified.

Teacher's Signature

$\frac{I R_2}{R_1+R_2}$ R_1





Observation

	Voltage Source	I_L	I_{SC} or I_N	R_N	I_L'
1)	5V	0.75A	1.74A	2.87 kΩ	0.79A
2)	10V	1.12A	3.35A	2.87 kΩ	1.22 A
3)	15V	1.56 A	5.18A	2.87 kΩ	1.47A
4)	20V	2.28A	6.81A	2.87 kΩ	2.20A

Calculation

$$R_N = (R_1 \| R_2) + R_3$$

$$= \frac{2.2 \times 1}{3.3} + 2.2 = 0.667 + 2.2 = 2.87\ k\Omega$$

Result

Norton's theorem is verified both practically and theoretically as by the above given data we can see that $I_L \cong I_L'$.

Precautions

1) Check for proper connections before switching on the supply
2) The terminals of the resistors must be properly connected.
3) Do not alter the circuit while keeping the DC source ON, Switch off the DC source and then alter the circuit as required.

Teacher's Signature

Validation

The measured values are a little deviated from the theoretical values. This error is due to computation error or due to error in measuring device.