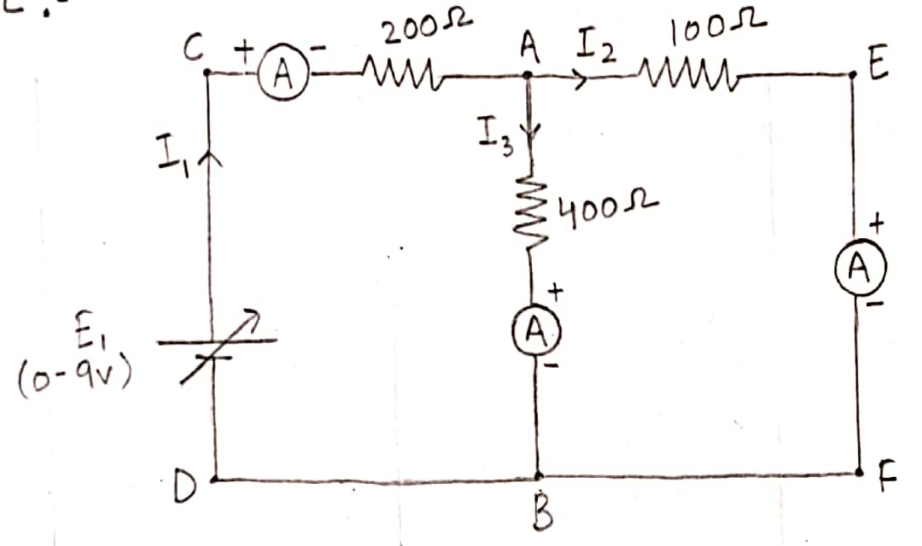
EXPERIMENT No. 1

AIM: To verify Kirchoff's current law and voltage law.

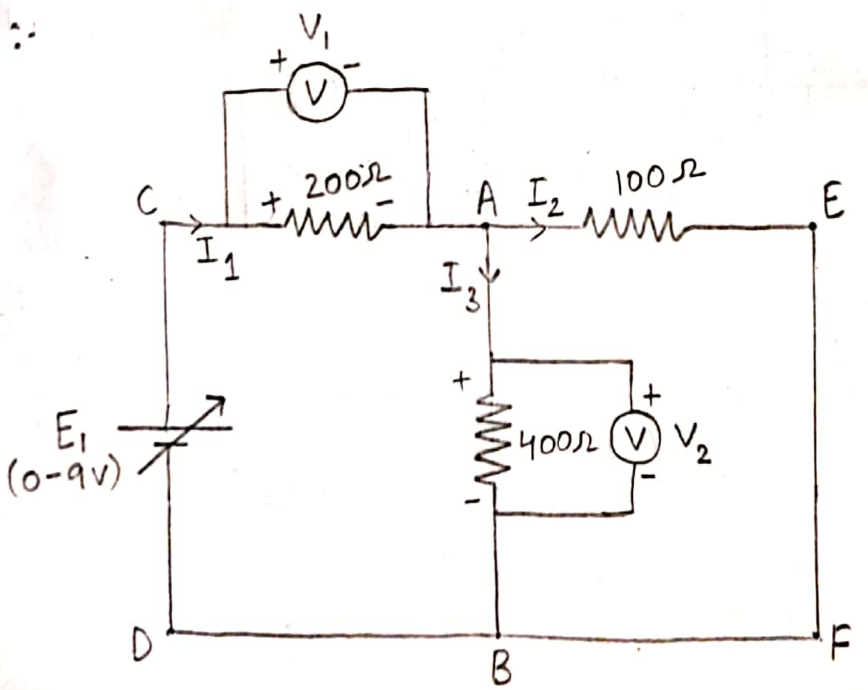
APPARATUS: DC supply (0-9V), Voltmeter (0-9V), Ammeter (0-60A), Resistors (200Ω, 100Ω, 400Ω), connecting wires.

CIRCUIT DIAGRAM:

For KCL :-



For KVL :-



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APPARATUS: DC supply (0-9V), Voltmeter (0-9V), Ammeter (0-60A), Resistors (200 Ω, 100 Ω, 400 Ω), connecting wires.

THEORY: Kirchoff's circuit Law (KCL):

In any electrical network, the algebric sum of current meeting at a point (or junction) is zero.

→ Mathematically $\Sigma I = 0$

Take Incoming current as +ve
Outgoing current as −ve

$$I_1 - I_2 - I_3 - I_4 + I_5 = 0 \qquad \text{[see fig.(1)]}$$

$$I_1 + I_5 = I_2 + I_3 + I_4$$

Incoming current = Outgoing current

Kirchoff's Voltage Law (KVL):

The algebric sum of the products of current and resistances in each of the conductors in any closed path in a network plus the algebric sum of emf's in that part is zero.

$$\rightarrow \quad \Sigma IR + \Sigma emf = 0$$

i.e. $E - I_1R_4 - I_1R_1 - I_1R_2 - I_1R_5 - I_1R_3 = 0$

[see fig (2)]

SIGN CONVENTIONS:

(a) Sign of Battery Emf

OBSERVATION TABLE :

For KCL :-

E_1	I_1 (mA)	I_2 (mA)	I_3 (mA)	Error $I_1-(I_2+I_3)$
3v	7	6	1	$7-(6+1)=0$ mA
6v	20	16	3	$20-(16+3)=1$ mA
9v	22	17	4	$22-(17+4)=1$ mA

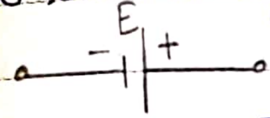
For KVL :-

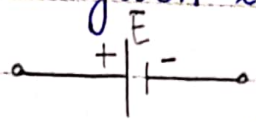
E_1	V_1	V_2	Error $E_1-(V_1+V_2)$
3v	2.14	0.86	$3-(2.14+0.86)=0$
6v	4.29	1.71	$6-(4.29+1.71)=0$
9v	6.43	2.57	$9-(6.43+2.57)=0$

RESULT :

From the observations and calculations, KCL and KVL has been verified.

Rise in voltage should be given a +ve sign.
Fall in voltage should be given a −ve sign.

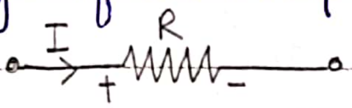


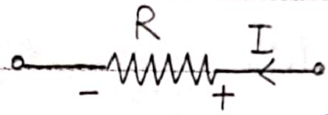


$\longrightarrow +E$ Rise in voltage

$\longrightarrow -E$ Fall in voltage

(b) Sign of IR drop





$\longrightarrow -IR$ Fall in voltage

$\longrightarrow +IR$ Rise in voltage

PROCEDURE : for KVL :-

1. connect the circuit as shown in Fig. (3).
2. First, set the input voltage supply to 3V and then connect each of the three resistors (200Ω, 100Ω & 400Ω) one by one in series with the ammeter on the kit.
3. Now, note the readings of ammeter with each of the resistors and name the current as I_1, I_2 and I_3.
4. check that the readings of current should satisfy this equation $I_1 = I_2 + I_3$ or $I_1 - I_2 - I_3 = 0$
5. Repeat steps 2,3,4 with 6V and 9V as input voltage supply.
6. Switch off the supply.

For KCL :-

1. connect the circuit as shown in Fig. (4). in the given kit.

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2. First, set the voltage supply to 3V and connect each of the ~~three~~ resistors ($200\,\Omega$, ~~$100\,\Omega$~~ and $400\,\Omega$) one by one in parallel with voltmeter on the kit.
3. Now, note the readings of voltmeter with each of the resistors and name the obtained value of voltage as V_1, V_2 respectively.
4. Find the error, if any, by the equation-

   $E-(V_1+V_2)$.
5. Now, repeat the steps 2,3 & 4 with 6V and 9V as input voltage supply.
6. Switch off the supply.

PRECAUTIONS :

1. Check the zero settings of instruments before their use.
2. All connections should be tight.
3. Direction of current should be kept in mind.

RESULT : From the observations and calculations, both the KVL and KCL has been verified.

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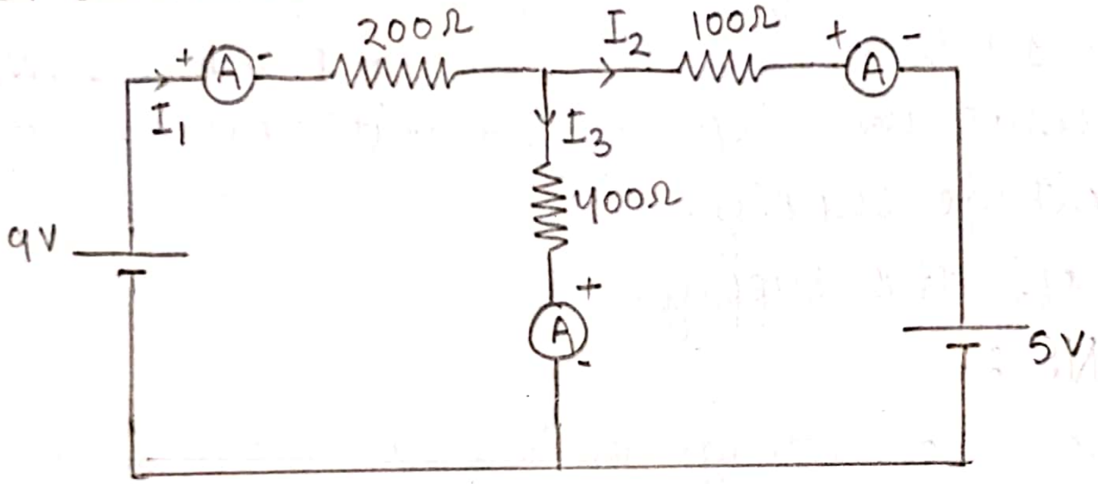
EXPERIMENT NO. 2

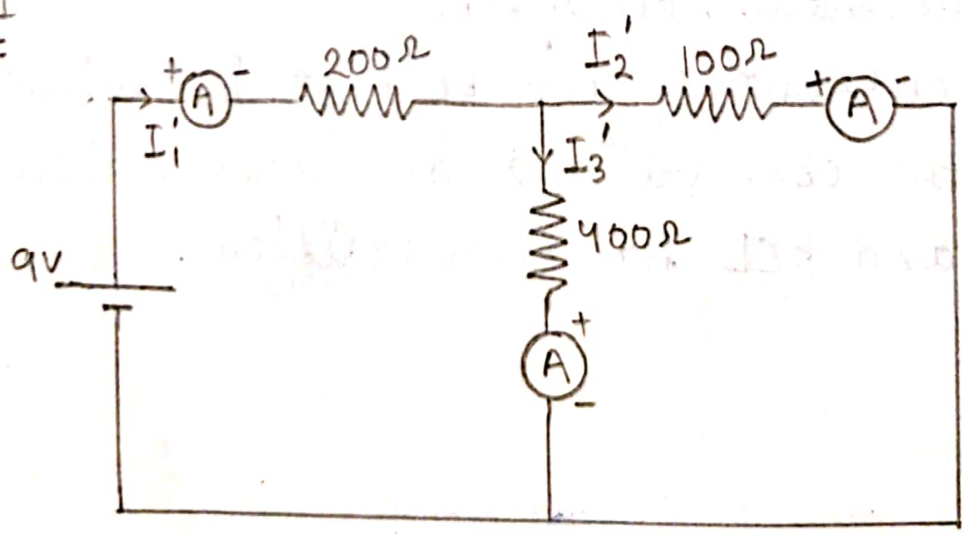
AIM: To verify Superposition Principle theorem.

APPARATUS REQUIRED: DC supply (0-9V), voltmeter (0-9V), wires, Ammeter (0-60A), Resistors 200Ω, 100Ω, 400Ω.

CIRCUIT DIAGRAM:



Step-I



EXPERIMENT NO. 2

AIM: To verify Superposition Principle or theorem

APPARATUS REQUIRED: DC supply (0-9V), Voltmeter (0-9V), wires, Ammeter (0-60A), Resistors 200Ω, 100Ω, 400Ω,

THEORY: According to this theorem, if there are two or more than two sources of emf's acting simuntaneously in a linear bilateral network, the current flowin through any section is the algebraic sum of all the currents which should flow in that section if each source of emf were considered separately and all other sources are replaced by their initial resistance

PROCEDURE:

1. Connect the circuit as shown in Fig. (1).
2. Now find the current through each resistor by connecting them one by one with the ammeter. From this, you will get values of I_1, I_2 and I_3.
3. For verifying superposition theorem, the first step we have to follow is to cut off 5V battery.
4. Then after shot-circuiting 5V battery, find out the currents in the three resistors shown in Fig. (2), by connecting ammeter one by one with the three resistors.
5. Name these currents I_1', I_2', I_3'. Now repeats these steps by short-circuiting 9V battery and this will give values of I_1'', I_2'' and I_3''.

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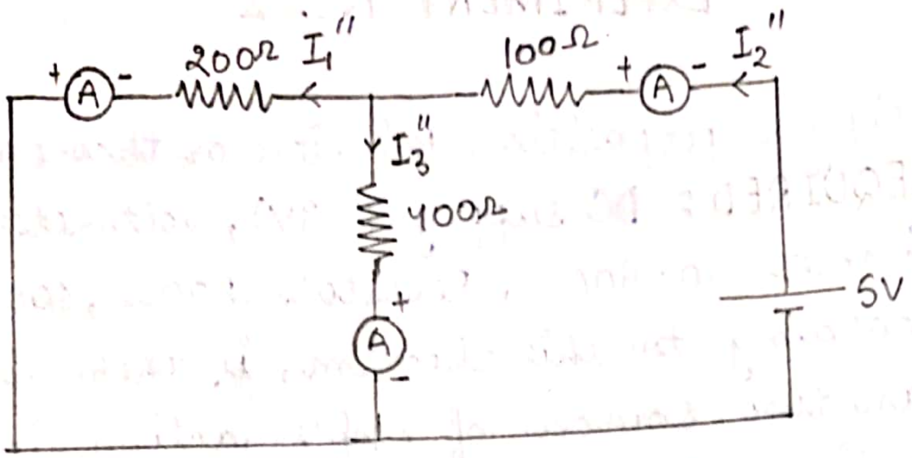
Step - II



OBSERVATION TABLE :

Supply voltage	Current to mA			Error (mA)
9V	$I_1 = 20$	$I_1' = 32$	$I_1'' = 13$	$I_1 - (I_1' - I_1'') = 1$
	$I_2 = 7$	$I_2' = 26$	$I_2'' = 19$	$I_2 - (I_2' - I_2'') = 0$
5V	$I_3 = 13$	$I_3' = 7$	$I_3'' = 6$	$I_3 - (I_3' - I_3'') = 0$

RESULT :

From the above calculations and observations, the superposition theorem is verified.

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6. Now here, I_1 must be equal to $I_1' + I_1''$ and same with I_2 and I_3 and if not this then there must be some error in your calculation or circuit.

PRECAUTIONS:

1. Direction of current should be correctly identified.
2. Check zero setting of instruments before connection, rheostat terminals.
3. Connections should be tight.
4. Ratings of currents to be kept in mind.

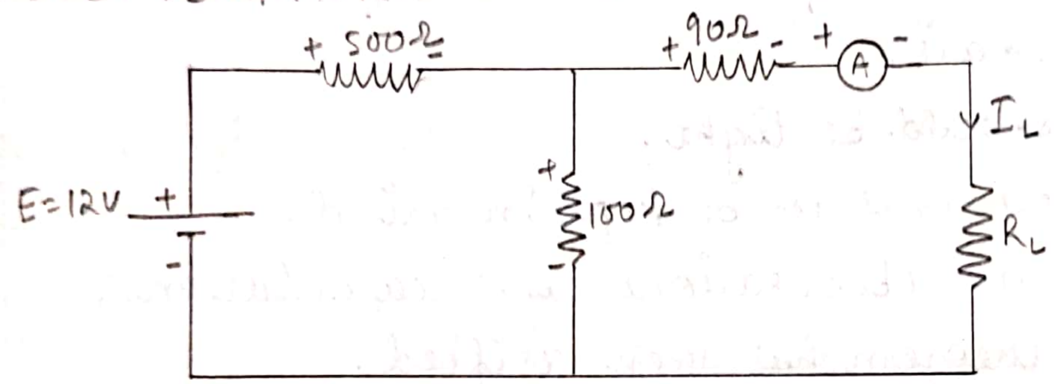
RESULT: From the observations and calculations, superposition theorem has been verified.

EXPERIMENT → 3

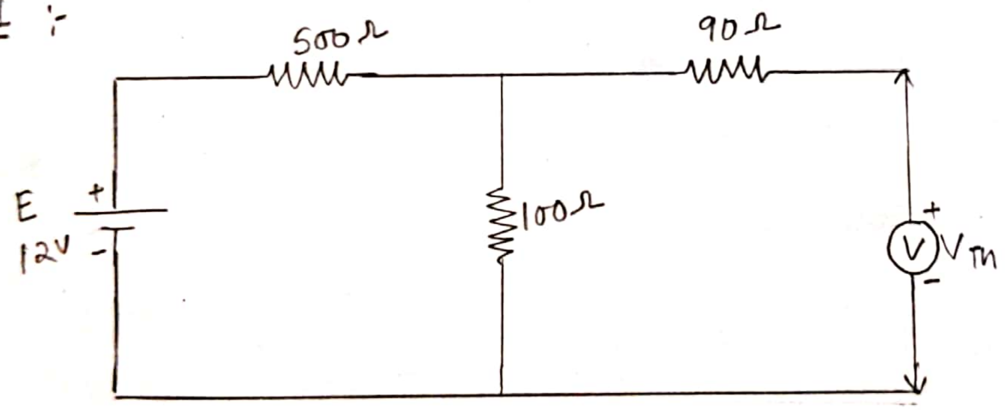
AIM : To verify Thevenin's theorem.

APPARATUS : DC supply, voltmeter, Ammeter, Resistor (500 Ω, 100 Ω, 90 Ω)

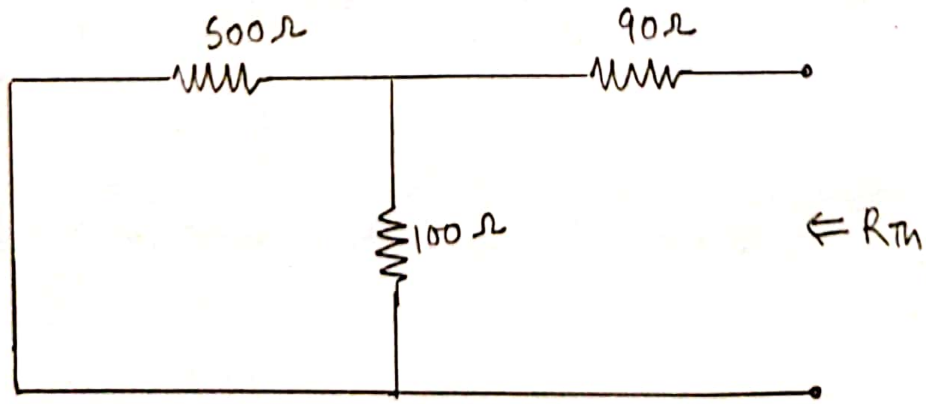
CIRCUIT DIAGRAM :



Step - I :-



Step - II :-



$R_{Th} = 173.33\,\Omega$

EXPERIMENT No. 3

AIM: To verify Thevenin's theorem.

APPARATUS REQUIRED: DC supply, voltmeter, Ammeter, resistor (500Ω, 100Ω, 90Ω)

THEORY: The current flowing through a load resistance 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 open circuit voltage.

i.e. voltage across the two terminals when R_L is removed.

R_{Th} is the internal resistance of network as viewed back into the open circuit network from terminals A and B with all voltage sources replaced by their internal resistance and current source by open circuit.

PROCEDURE:

1. Make the connections on the kit as shown in figure & switch on DC supply. This will give load current across different load resistance connected by ammeter.
2. Now make the connections according to second figure i.e. open circuit load terminal and give 12V supply. This will give us open circuit voltage i.e. V_{Th}.
3. Make the calculation as shown is figure 3 and calculate R_{Th}.
4. Now we have V_{Th} and R_L, so with these values we can calculate I_L. $\left(I_L = \dfrac{V_{oc}}{R_{Th} + R_L} \right)$

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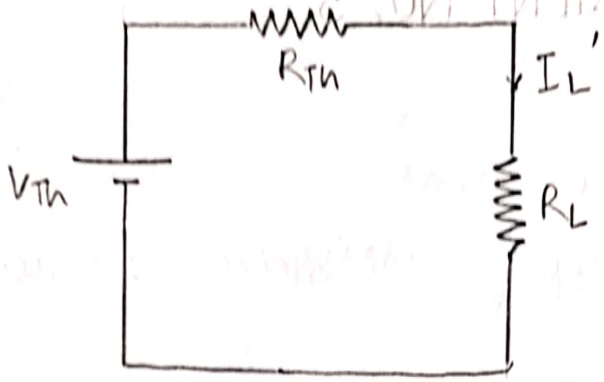
Step-III :-



$$I_L' = \frac{V_{Th}}{R_{Th}+R_L}$$

OBSERVATION TABLE :-

E(V)	$R_L(\Omega)$	I_L(mA)	V_{Th}(V)	$R_{Th}(\Omega)$	I_L'(mA)	Error ($I_L - I_L'$)
12	25	8	1.75	173.33	3.8	0.8 mA
12	50	7	1.75	173.33	7.8	0.8 mA
12	100	5.5	1.75	173.33	6.4	0.9 mA

RESULT :-

From the above calculations and observations, Thevenin's theorem is verified.

PRECAUTIONS:

1. Meters should be used within proper range.
2. We must use neat and tight connections.
3. Zero setting of all meters should be checked before giving input supply.

RESULT:

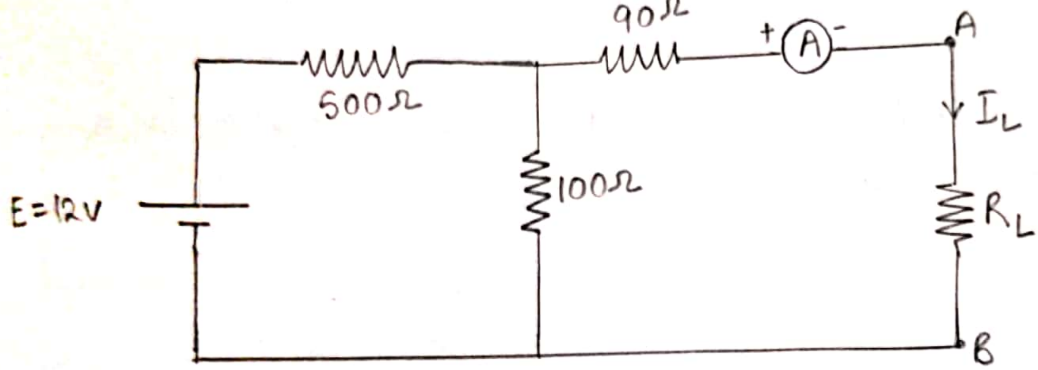
From the above observations and calculations, thevenin's theorem is satisfied/verified.

EXPERIMENT → 4

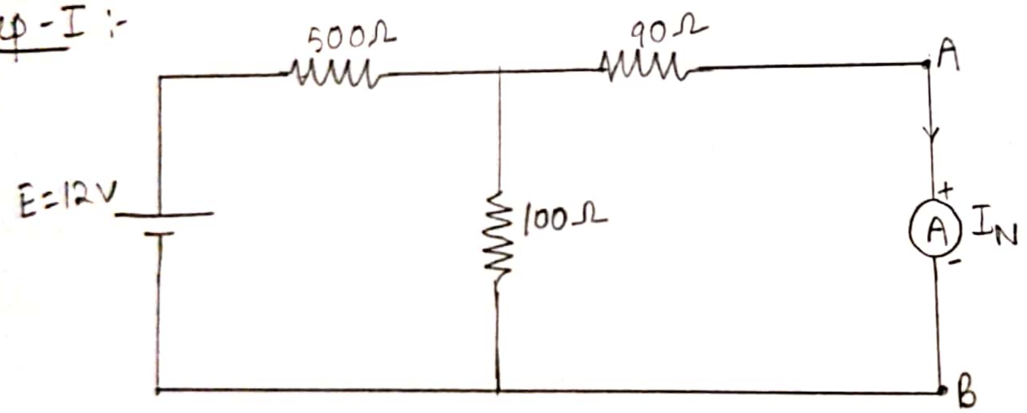
AIM : To verify Norton's theorem.

APPARATUS : AC supply, voltmeter, ammeter, Resistance (500 Ω, 90 Ω & 100 Ω)

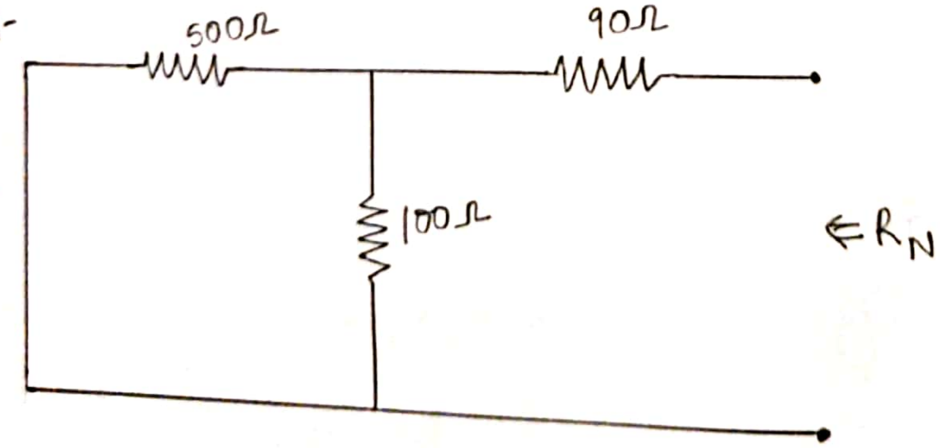
CIRCUIT DIAGRAM :



Step - I :-



Step - II :-



EXPERIMENT No.4

AIM: To verify Norton's theorem

APPARATUS: DC supply, voltmeter, ammeter, Resistance (500Ω, 100Ω, 90Ω)

THEORY: The current flowing through a resistance connected across any two terminals of a network can be determined by replacing the whole networking by an equivalent circuit of a current source having a current output of I_N in parallel with resistance R_N, where I_N = short circuit current supplied by the source that would flow between the two selected terminals when they are short circuited.

R_N = Equivalent resistance of the networks as seen from the two terminals with all other emf sources replaced by their internal resistance and current source replaced by open circuit.

PROCEDURE:

1. Make the connections as shown in the circuit diagram and measure the value of current 'I_L' across 'R_L' with the help of ammeter at DC supply of 12V.
2. Now, by removing load resistance 'R_L', short the circuit across terminals AB in diagram (1) and measure the value of short circuit current 'I_N' with the help of ammeter.
3. Calculate the equivalent resistance 'R_N' from the diagram (2).

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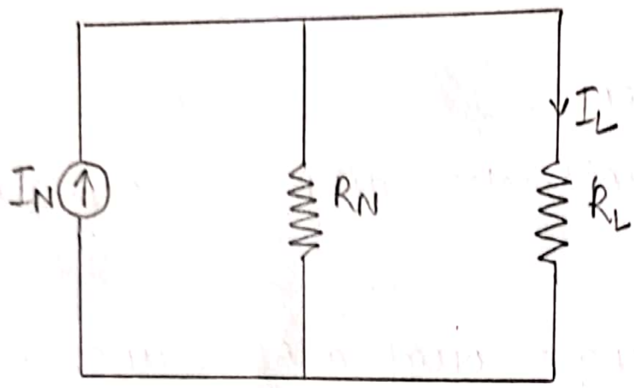
Step-III :-



$$I_L' = \frac{R_N}{R_N + R_L} \times I_N$$

OBSERVATION TABLE :

E	R_L	I_L	I_N	R_N	I_L'	Error ($I_L - I_L'$)
12V	25Ω	8mA	10mA	173.33Ω	8.7mA	0.7mA
12V	50Ω	7mA	10mA	173.33Ω	7.7mA	0.7mA
12V	100Ω	5.5mA	10mA	173.33Ω	6.3mA	0.9mA

RESULT :

From the above observations and calculations, Norton theorem has been verified.

4. Hence, find the value of current 'I_L' by using formula:

$$I_L = \frac{R_N}{R_N + R_L} \times I_N$$

PRECAUTIONS:

1. All the connections should be correct & tight.
2. Zero setting of all meters should be checked before givin the input supply.
3. Readings should be noted carefully.

RESULT:

From the above observations and calculations, Norton's theorem has been verified.