Department of Information and Communication Engineering
Pabna University of Science and Technology
B.Sc. (Engineering) 1st Year 2nd Semester Examination-2017
Course Code: ICE-1206 **Course Title:** Circuit Theory and Analysis Sessional

E1. Study and verify Maximum Power Transfer Theorem.
E2. Study and verify Superposition Theorem for two-terminal linear bilateral dc network.
E3. Study and verify Thevenin's Theorem for two-terminal linear bilateral dc network.
E4. Study and verify Norton's Theorem for two-terminal linear bilateral dc network.
E5. Study and verify Millman's Theorem for two-terminal linear bilateral dc network.
E6. Study and verify Mesh Analysis procedure for solving two-terminal linear bilateral dc network.

PABN ... OLOGY

Department of
Information and Communication Engineering
Faculty of Engineering and Technology

LAB REPORT

Crouse Title : Circuit Theory and Analysis Sessional

Crouse Code : ICE - 1206

Submitted By :

Name : Joy Saha

Roll : 190635

Session : 2018 – 2019

1^{st} year 2^{nd} semister

Department of ICE , PUST

I C E I C E

Submitted To :

Sohag Sarker

Assistant Professor ;

Tarun Debnath

Lecturer;

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Signature ....

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02	To study the Superposition theorem.
03	To study Maximum Power Transfer theorem.
04	To study the Thevenin’s theorem.
05	To study the Norton's theorem.
06	To study the Reciprocity theorem.

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Department of

Information and Communication Engineering

Faculty of Engineering and Technology

LAB REPORT

Crouse Title : Circuit theory and Analysis Sessional

Crouse Code : ICE - 1206

Experiment No : 01

Experiment Name : To ~~veritification~~ the series Parallel DC circuit.

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Experiment name: To verification the series parallel DC circuit.

Objectives:

1. Explain how total voltage is determine in series circuits.
2. Explain how total current is determine in parallel circuits.
3. Calculate total resistance in a series/parallel circuit.
4. Take total resistance measurements.
5. Calculate wattage.

Theory:

Series circuit: A circuit composed solely of components connected in series is known as a series circuit. In a series circuit, the current that flows through each of the components is the same and the voltage across the circuit is the sum of the individual voltage drops across each component. In a series circuit, every device must function for the to be complete. If one bulb burns out in a series circuit, the entire circuit is broken.

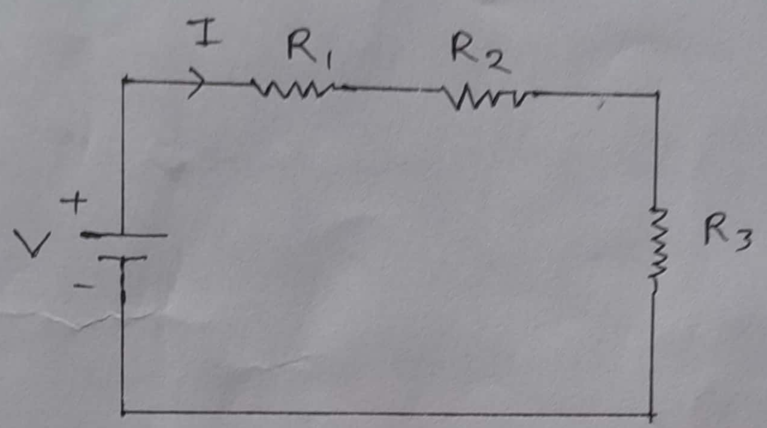

Fig: series circuit

The total resistance of resistance units in series is equal to the sum of their individual resistances.

$$R_{total} = R_1 + R_2 + R_3$$

In a series circuit, the current is the same for all of the elements.

$$I = I_1 = I_2 = I_3$$

In a series circuit, the voltage is the sum of the voltage drops of the individual components

$$V = V_1 + V_2 + V_3$$

Parallel circuit: A circuit composed solely of one connected completly in parallel circuit. In a parallel circuit. In the voltage across each of the components is the same. and the total current is the sum of the currents ~~is the~~ flowing through each component:

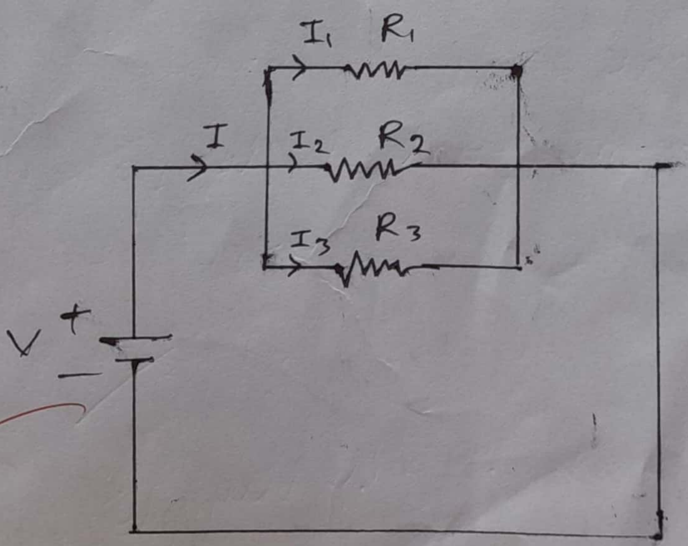

Fig: Parallel circuit.

The total resistance of resistance units in parallel is equal to the sum of the inverse of their individual resistance.

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

The same voltage is applied to all circuit components connected in parallel.

$$V = V_1 = V_2 = V_3$$

The total current is the sum of the currents through the individual components in accordance with kirchhoff's current law

$$I_1 = \frac{V}{R_1}$$

$$I_2 = \frac{V}{R_2}$$

$$I_3 = \frac{V}{R_3}$$

Series - Parallal circuit: A series parallel circuit is a combination of series and parallel circuit. It may certains series and parallel and voltage source.

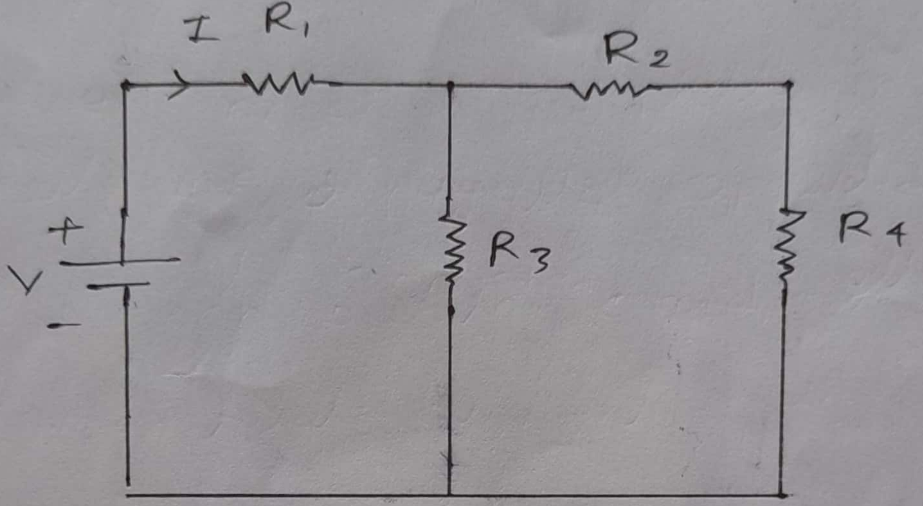

Fig: series-parallel circuit.

From figure R_2, R_4 resistance are connected in series and connected with parallel in resistor R_2 and R_1 is.

$$\therefore R_T = R_1 + R_3 \parallel (R_2 + R_4)$$

$$V \neq V_1 = V_2 = V_3 = V_4$$

$$I = I_1 + I_2$$

Apparatus:

(I) Bread - Board;

(II) Resistors;

(III) DC power supply;

(IV) AVO meter;

(V) connecting wires;

(VI) calculator;

Circuit Diagram:

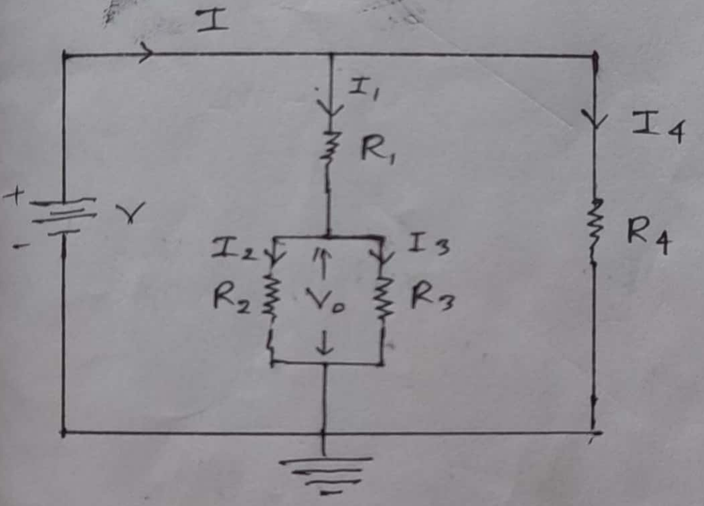

Fig: series - Parallal circuit

Experiment table:

Table 01: Experimental data table for voltage.

No of observation	Input voltage Vin (V)	Output Voltage Volt (v) calculated	Output voltage (mv) measured	Error (%)
01	3.61	174	170	2.30%
02	4.23	203.8	200	1.87%
03	5.08	244.8	244.7	0.41%
04	6.08	293	290	1.02%
05	6.80	327.76	320	2.37%
06	7.24	348	340	2.30%
07	8.02	386	380	2.55%
08	9.04	436	430	1.38%
09	9.65	465	460	1.08%
10	10.36	497	490	1.01%

Table 02 : Experimental data table for current:

No of observation	Input Voltage V_s (V)	Input current I_s (mA)	Calculated I_1 (mA)	measured I_1 (mA)	Calculated I_4 (mA)	measured I_4 (mA)	Calculated $I_1 + I_4$ (mA)	measured $I_1 + I_4$ (mA)	Error (%)
1	2.18	4	1.6	1.5	2.4	2.4	4	3.9	2.5%
2	3.49	6.1	2.44	2.4	3.66	3.60	6.1	6.0	1.6%
3	4.25	7.2	2.88	3.0	4.32	4.40	7.2	7.4	2.8%
4	5.30	8.9	3.56	3.6	5.34	5.40	8.9	9.0	1.1%
5	6.53	11.10	4.44	4.44	6.64	6.60	11.1	11.04	0.5%
6	7.63	13	5.20	5.2	7.8	7.8	13	13	0%
7	8.28	14.4	5.76	5.6	8.64	8.60	14.4	14	2.8%

Result and discussion:

In this experiment ~~ed~~ we create two table. One for voltage and another is for current. In both table the value of calculated and measured voltage and current are appoximatally same. There is a slight error. So we can say that, we get approximately the accourate result.

Precuation: (I) All the components and connecting wire connected carefully.

(II) Voltage across each resistor were measured very carefully.

(III) Current are measured carefully in the circuit.

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LAB REPORT

Crouse Title : Circuit theory and Analysis Sessional

Crouse Code : ICE - 1206

Experiment No : 02

Experiment Name : To study the superposition theorem.

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Submission Date : 12.01.20	Signature 21.01.2020

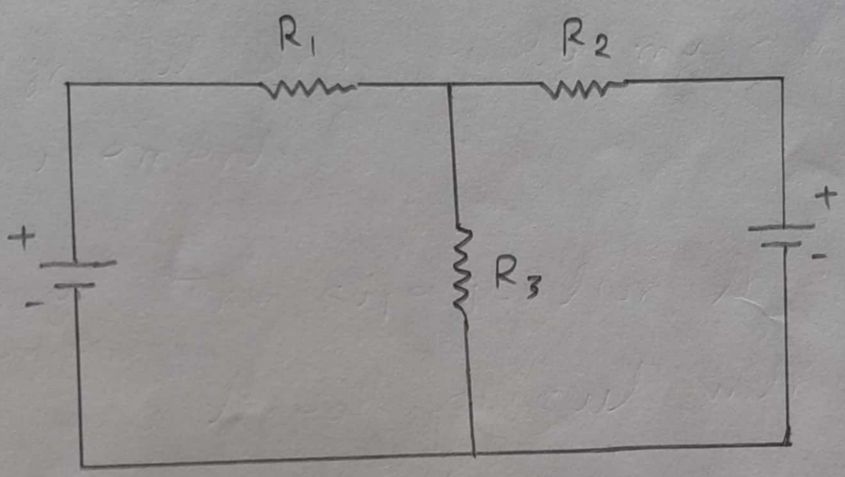
I C E I C E

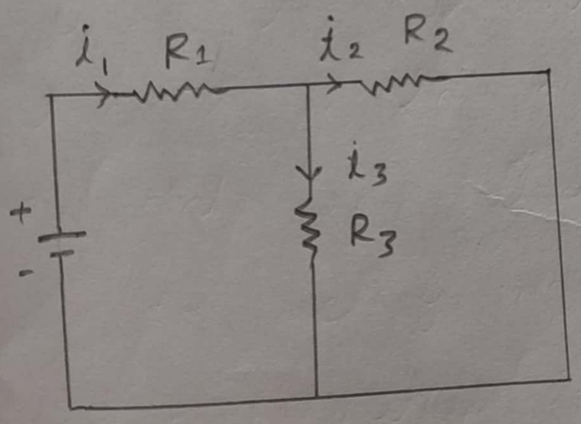
Experiment Name : To study the superposition theorem,

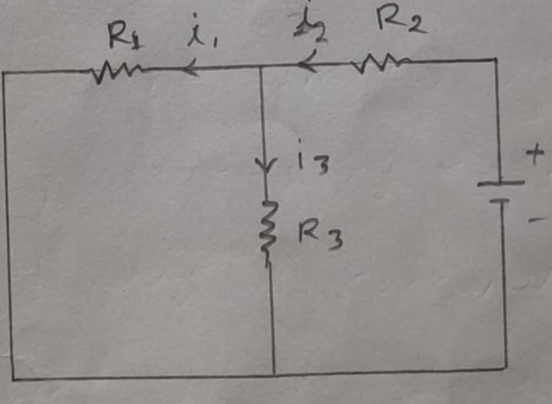
Objectives : ① Apply the superposition to linear circuits with more than one voltag source.

⑪ Construct a circuit with two voltage sources, solve for currents and voltages through out and verify my computation by measurements.

Theory : The superposition theorem states that in a linear circuit with several sources, the current and voltage for any element in the circuit is the sum of the currents and voltages produced by each source acting independently. To calculate the contribution of each source independently, all the other sources must be removed and replaced without affecting the final result. When removing a voltage source. It's voltage must be set to zero, which is equivalent to replacing the voltage source with a short circuit, when removing a current source. It's current must be set to zero, which is equivalent to replacing the current source with an open circuit.







For first circuit,

$$i_1' = \frac{V_1}{\frac{R_2 R_3}{R_2 + R_3} + R_1}$$

$$i_2' = i_1' \times \frac{R_3}{R_2 + R_3}$$

$$i_3' = i_1' - i_2'$$

For second circuit,

$$i_1'' = i_2'' \times \frac{R_3}{R_1 + R_3}$$

$$i_2'' = \frac{V_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}}$$

$$i_3'' = i_2'' - i_1''$$

For full circuit,

$$i_1 = i_1' - i_2''$$

$$i_2 = i_2' - i_2''$$

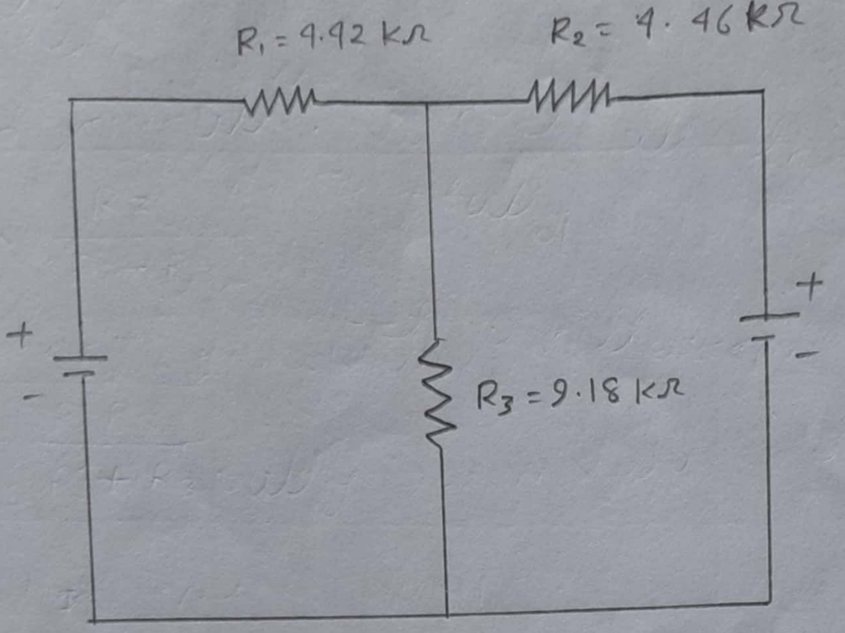
$$\cancel{i_3 = i_3'''}$$

$$i_3 = i_3' + i_3''$$

Experimental Requirement:

1. Bread board;
2. Resistors;
3. Two voltage source;
4. AVO meter;
5. Connecting wire;
6. calculator;

Circuit Diagram:



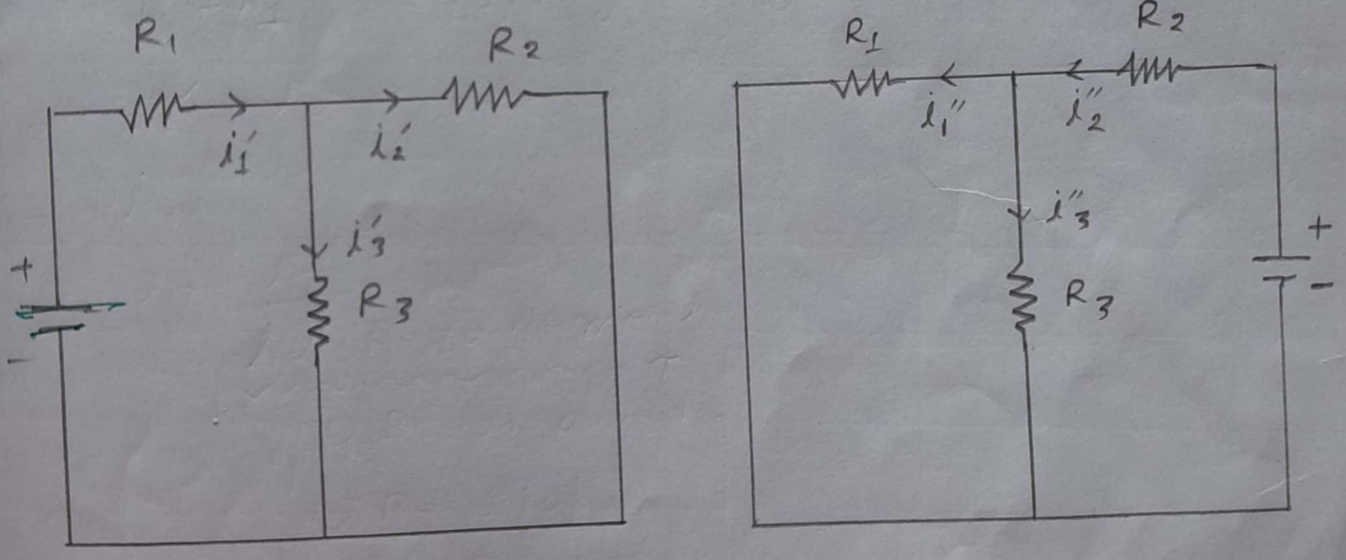


Fig: Experimental circuit for superposition theorem

Experimental Table : Experimental data for superposition theorem:

No of Obser-vation	input Voltage V_1 (volt)	input Voltage V_2 (volt)	Calculeted value									Measured value		
			i_1' mA	i_2' mA	i_3' mA	i_1'' mA	i_2'' mA	i_3'' mA	i_1 mA	i_2 mA	i_3 mA	i_1 mA	i_2 mA	i_3 mA
01	4.8	3.3	0.60	0.40	0.20	0.29	0.44	0.14	0.30	0.04	0.34	0.3	0.1	0.3
02	6.04	4	0.81	0.54	0.27	0.35	0.53	0.18	0.46	0.01	0.45	0.4	0.1	0.3
03	7.08	5	0.95	0.63	0.32	0.45	0.67	0.22	0.56	0.04	0.54	0.4	0	0.4
04	8.2	7.2	1.10	0.74	0.36	0.65	0.96	0.31	0.45	0.22	0.67	0.5	0.02	0.6
05	9.1	8.3	1.22	0.81	0.41	0.76	1.12	0.36	0.46	0.31	0.77		0.42	

Result and Discussion: From the table we saw the current across the resistor. The calculation of current is:

First of all, we put the element,

$R_1 = 4.42\ k\Omega$

$R_2 = 4.46\ k\Omega$

$R_3 = 9.18\ k\Omega$

$V_1 = 4.80\ V$

$V_2 = 3.3\ V$

When the second voltage source is removed, we get the value of i_1', i_2', i_3'

$$i_1' = \frac{V_1}{\frac{R_2 R_3}{R_2 + R_3} + R_1}$$

$$= \frac{4.80}{\frac{4.46 \times 9.18}{4.46 + 9.18} + 4.42}$$

$$= 0.60\ mA$$

$$i_2' = i_1' \times \frac{R_3}{R_2 + R_3}$$

$$= 0.60 \times \frac{9.18}{4.46 + 9.18}$$

$$= 0.40\ mA$$

$i_3' = i_1' - i_2'$

$= 0.60 - 0.40$

$= 0.20\ mA$

Then we remove the first voltage source and get the value of i_2'', i_1'' and i_3''.

$$i_2'' = \frac{V_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}}$$

$$= \frac{3.3}{4.46 + \frac{4.42 \times 9.18}{4.42 + 9.18}}$$

$= 0.44\ mA$

$$i_1'' = i_2'' \times \frac{R_3}{R_1 + R_3}$$

$$= 0.44 \times \frac{9.18}{4.42 \times 9.18}$$

$= 0.297\ mA$

$i_3'' = i_2'' - i_1''$

$= 0.44 - 0.297$

$= 0.143\ mA$

Now,

$i_1 = i_1' - i_1''$

$= 0.60 - 0.297$

$= 0.3\ mA$

$i_2 = i_2' - i_2''$

$= 0.4 - 0.44$

$= -0.04$

$i_3 = i_3' + i_3''$

$= 0.20 + 0.14$

$= 0.34$

Similarly we got the value of current by changing voltage

We used to various voltage for the analyzed of superposition theorem. we measured the value of current from the circuit. We got calculated value of current from the circuit. From the table we saw the measure current and calculated current are almost same. we get some error.

Precaution: ① Firstly we set up all the required component onthe bread board with their required values.

(ii) All the connection should be jointed properly and carefully.

(iii) We measured the output current very carefully.

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Faculty of Engineering and Technology

LAB REPORT

Crouse Title : Circuit theory and Analysis Sessional

Crouse Code : ICE - 1206

Experiment No : 03

Experiment Name : To study maximum power transfer theorem.

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Session : 2018 – 2019	E	Tarun Debnath
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Department of ICE , PUST	C	Department of ICE , PUST
Submission Date :	E	Signature .... [illegible].2020.

Experiment Name: To study maximum power transfer theorem.

Objectives: ① To demostrate that maximum power will be delivered to the load in resistive circuits when load resistor is equal to the Thevenin Equivalent Resistance of the rest of the circuit.

(ii) To demostrate and experimentally ~~very~~ verify the maximum transfer theorem

(iii) Determine the value of a load resistor which with allow maximum power transfer to the load.

Theory: The maximum power transfer theorem states that the maximum power delivered from source to load. when the source resistance is equal to the load resistance. The maximum power transfer theorem is ~~used~~ to find the load resistance for which there would be maximum amount of power transfer from the source to the load.

A variable resistance R_L is connected to a DC source network as shown in the circuit diagram in figure A below and the figure B represents the Thevenin's voltage V_{th} and Thevenin's resistance R_{th} of the source network. The aim of the maximum power transfer theorem is to determine the value of load resistance R_L. Such that it receives maximum power from the DC source.

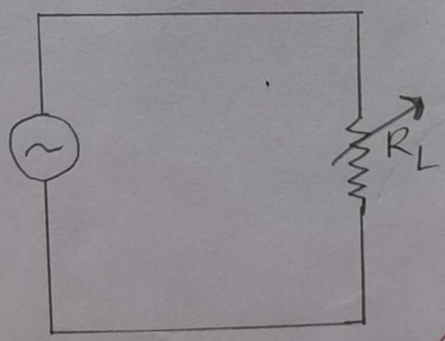

Figure : A

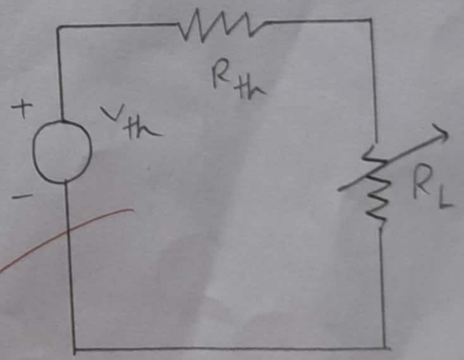

Figure : B

Considering figure-B the value of current will be calculated by the equation,

$$I = \frac{V_{th}}{R_{th} + R_L} \quad \text{——— (1)}$$

While the power delivered to the resistive load is given by the equation,

$$P_L = I^2 R_L \quad \text{——} \quad (11)$$

Putting the value of I from the equation (1) in the equation (11) we will get,

$$P_L = \left(\frac{V_{th}}{R_{th} + R_L}\right)^2 \times R_L$$

Again, with $R_{th} = R_L$, the system being ~~to~~ perfectly matched to the load and the source, thus, the power transfer becomes maximum and this amount of power P_{max} can be obtained by the equation shown below,

$$I = \frac{E_{th}}{R_{th} + R_L}$$

$$= \frac{E_{th}}{2R_{th}}$$

$$\therefore P_L = I_L^2 R_L = \left(\frac{E_{th}}{2R_{th}}\right)^2 \times R_{th}$$

$$= \frac{E_{th}^2}{4R_{th}}$$

Apperatus : (i) Bread board;

(ii) Resistors;

(iii) AVO meter;

(iv) Connecting wire;

(v) DC Power supply;

(vi) calculator;

Circuit Diagram:

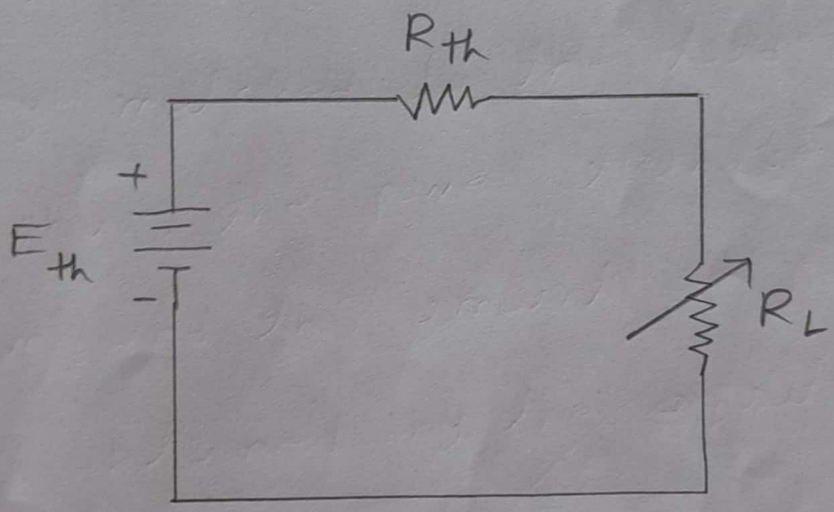

Figure: Experimental circuit

Experimental table: Experimental data table for maximum power transformer theorem

$V_{th} / E_{th} = 5V$

$R_{th} = 9.45 k\Omega$

No of observation	V_{in} (Volt)	R_{th} ($k\Omega$)	R_L ($k\Omega$)	Calculated Value		Measured Value		Error: $\frac{P_{cal} - P_{mea}}{P_{cal}} \times 100\%$
				I_L (mA)	P_L	I_L (mA)	P_L	
01	5	9.45	960Ω	0.48	0.22	0.45	0.19	13.6
02	5	9.45	6.71	0.31	0.64	0.28	0.52	18.75
03	5	9.45	9.45	0.26	0.66	0.24	0.54	18.18
04	5	9.45	21.75	0.16	0.56	0.14	0.42	25
05	5	9.45	22.45	0.16	0.55	0.13	0.38	31.16

Result: From the table we get the calculated and measured value of current and power. From the equation we get the value of current and power.

$$I_L = \frac{E_{th}}{R_{th} + R_L}$$

$$P_L = I_L^2 R_L$$

When we put $V_{in} = 5$ volt and R_{th} is fixed value $= 9.45$ and $R_L = 960\ \Omega$ we get the calculated value of current and power is,

$$I_L = \frac{E_{th}}{R_{th} + R_L}$$

$$= \frac{5}{9.45 + 0.96}$$

$$= 0.48 \, mA$$

$$P_L = I_L^2 R_L$$

$$= (0.48)^2 \times 0.96$$

$$= 0.22 \, mW$$

Similarly we filled up the table

Discussion: From the table and result we get the almost same current from calculated and measured. We also get almost same power from calculated and measured. From the table we get the maximum power when the source resistance is equal to the load resistance.

Precaution : (I) Firstly we ~~get~~ set up all the required component on the bread board with their required values.

(II) All the connection should be joined properly and carefully.

(III) We measured the input voltage and current very carefully.

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LAB REPORT

Crouse Title : Circuit theory and Analysis Sessional

Crouse Code : ICE - 1206

Experiment No : 04

Experiment Name : To study the Thevenin's Theorem

Submitted By :

Name : Joy Saha

Roll : 190635

Session : 2018 – 2019

1st year 2nd semister

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Submission Date : 9

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Submitted To :

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Signature .... 17.02.2020.

Name of the Experiment: To study the thevenin's theorem.

Objective(s): ① To Examine the use of thevenin's theorem to create simpler version of DC circuit an aid to analysis.

⑪ Multiple method of experimentally obtained the thevenin's resistance will be explored.

Theory: The thevonin's theorem states following that: Any two terminal dc network can be replaced on equivalent circuit consisting solely of a voltage source and series resistor.

Thevenin's Theorem procedure:

① Remove that portion of the network where thevenin's equivalent circuit is found.

⑪ Mark the terminal of the remaining two terminal network.

R_{th} : Calculate R_{th} by first ~~setting~~ all source to zero and then finding the resultant resistance between the two marked terminal.

E_{th} : Calculate E_{th} by first all source to the original position and finding the open circuit voltage between the mark terminal.

Conclution: Draw the thevenin's theorem equivalent circuit with the portion of the circuit remomead placed remarked replaced between the terminal of the equivalent circuit.

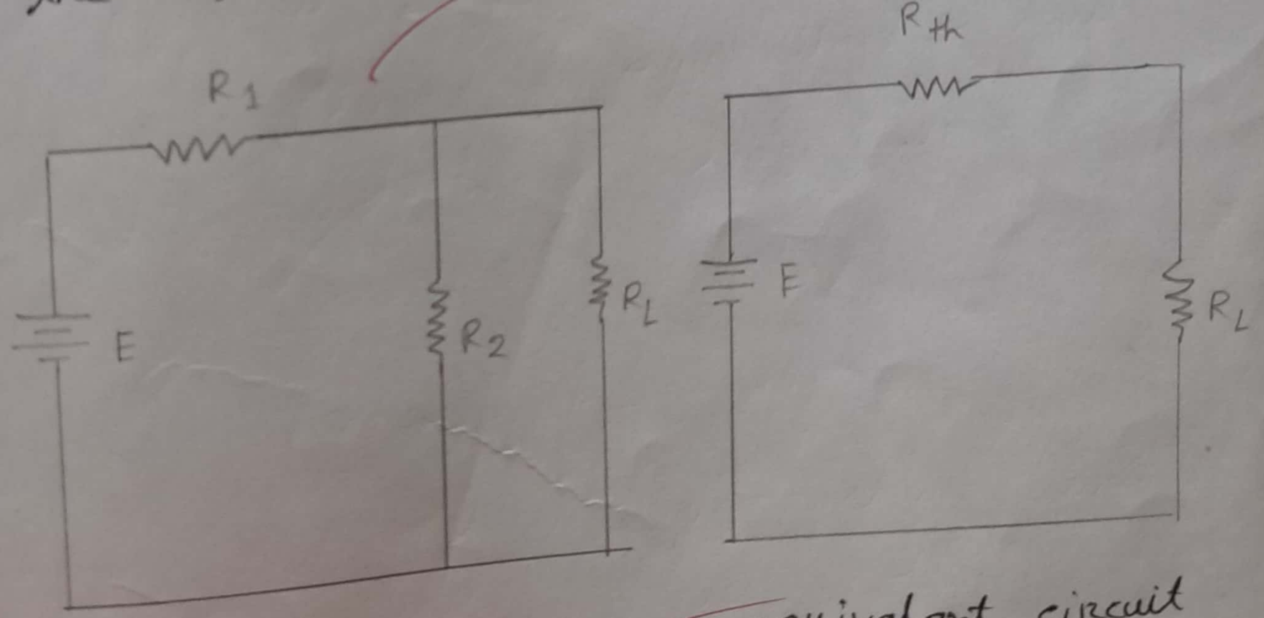


Fig: Thevenin's Theorem equivalent circuit for a complex network.

Experimental Requirement:

(I) Bread board;

(II) Resistor;

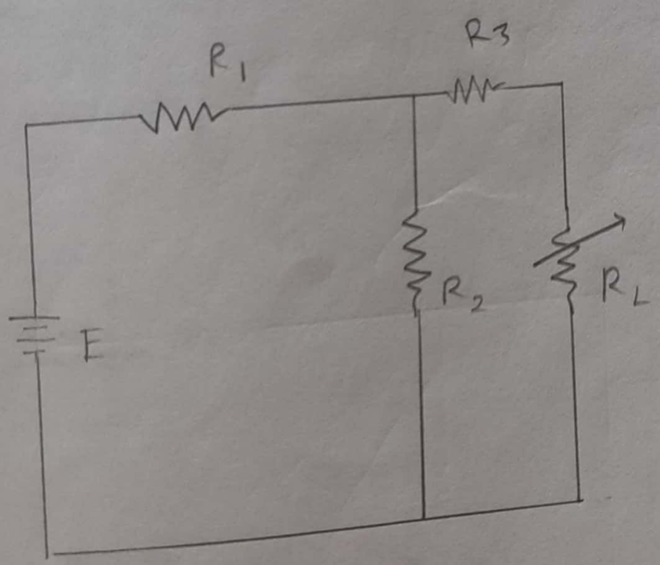
(III) DC supply;

(IV) Avo meter;

(V) Connecting wire

(VI) others.

Experimental circuit:



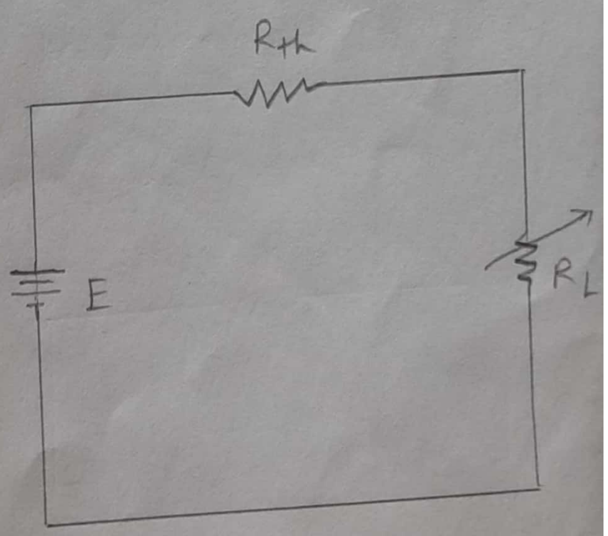


Fig: ~~Experimental~~ circuit for thevenin's theorem

Experimental Table: Experimental data table for thevenin's theorem.

No of observation	E_{th} (V)	R_{th} (kΩ)	R_L (kΩ)	Calculated current I_L (mA)	measured current I_L (mA)	Error %
1	7	2.08	4.7	1.03	0.98	5%
2	7	2.08	3.6	0.91	0.90	1%
3	7	2.08	8	0.69	0.60	6%
4	7	2.08	10	0.56	0.54	2%
5	7	2.08	22	0.29	0.28	1%

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LAB REPORT

Crouse Title : Circuit theory and Analysis Sessional

Crouse Code : ICE - 1206

Experiment No : 05

Experiment Name : To study Norton's Theorem.

Submitted By :

Name : Joy Saha

Roll : 190635

Session : 2018 – 2019

1st year 2nd semister

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Submission Date : ?

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Name of the Experiment: To study Norton's Theorem.

Objective(s): ① Validate Northon's Theorem through experimental measurements.

② Become aware of an experimental procudure to determine I_N, R_N. Hence the Northon equivalent circuit.

③ Demonstrate how Northon theorem can be used to simplify a circuit to one that contain three components: Power source, equivalent resistor and load.

Theorey: Northon's theorem state that.

Any linear by directional circuit having several sources and resistances can be replaced by just one single equivalent current source I_n in parrlall with single equivalent resistor R_N.

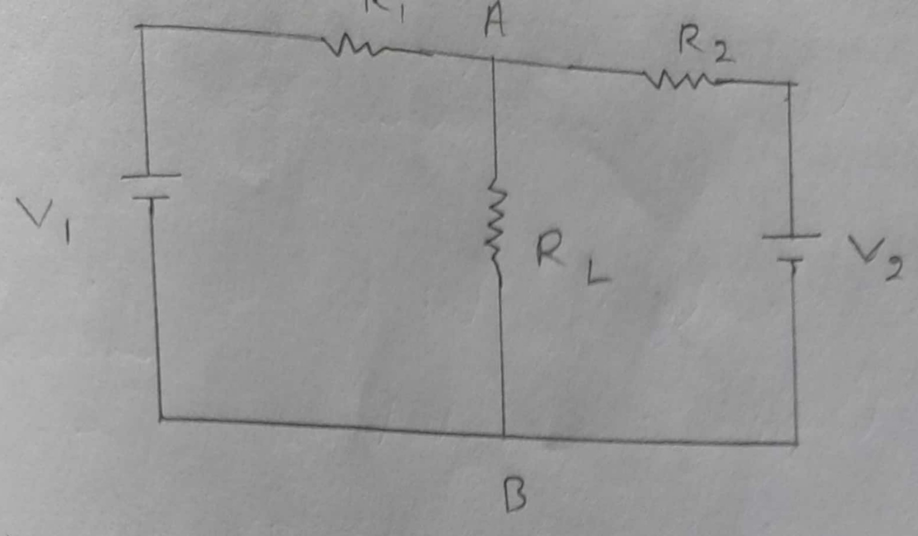


Fig: Circuit - 1

To find the Norton's equivalent of the above circuit ~~fully~~ firstly we have to remove the load resistance R_L and out the terminals A and B to make the following circuit.

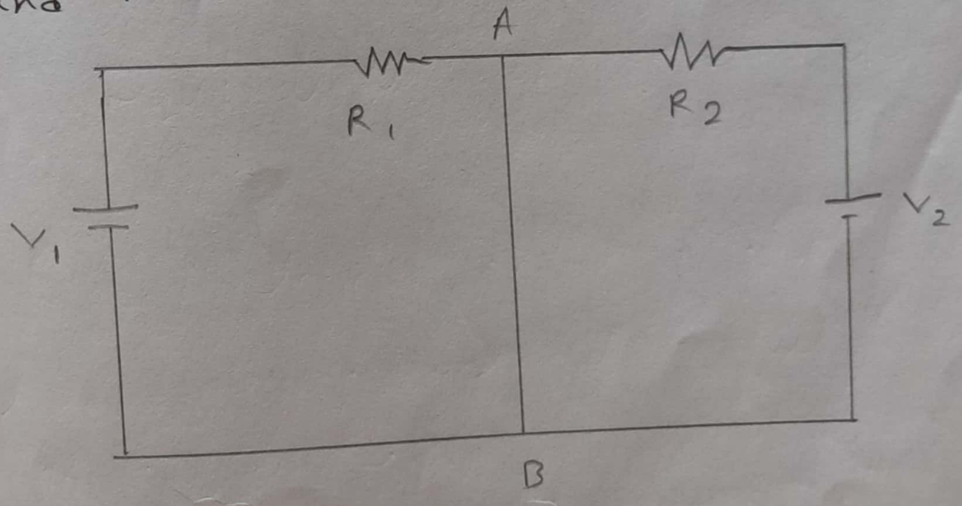


Fig: circuit - 2

When the terminals A and B are shorted together the two resistors are connected in parallel across their two respactive voltage sources and the currents flowing through each resistor as well as the total short circuit can now be calculated as

$$I_1 = \frac{V_1}{R_1}$$

$$I_2 = \frac{V_2}{R_2}$$

$$I = I_1 + I_2$$

If we short-out the two voltage sources and open circuit terminals A and B. the two resistors are now effectively connected together. in parallel. The value of norton resistance R_n is found by ~~as~~ calculating total resistance at the terminals A and B.

The following ~~chart~~. ~~circi~~ circuit.

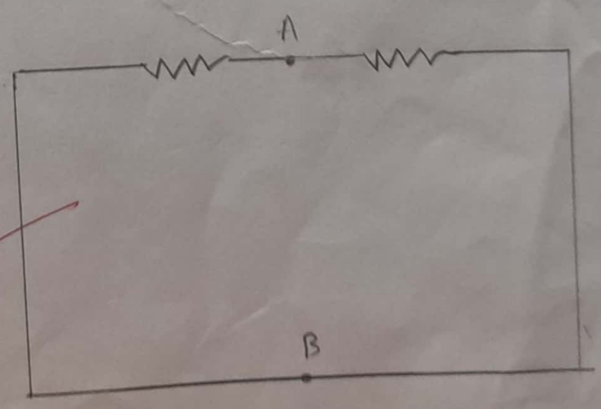


Fig: circuit :3

The equivalent resistance

$$R_N = \frac{R_1 R_2}{R_1 + R_2}$$

$$V = I_N R_1$$

$$\Rightarrow I_N = \frac{V}{R_1}$$

The load current, $I_L = I_N \times \frac{R_N}{R_N + R_L}$

Apparatus:

(I) Bread board;

(II) Resistor;

(III) Avo meter;

(IV) Connecting wire;

(V) DC power supply;

(VI) Calculator.

Circuit:

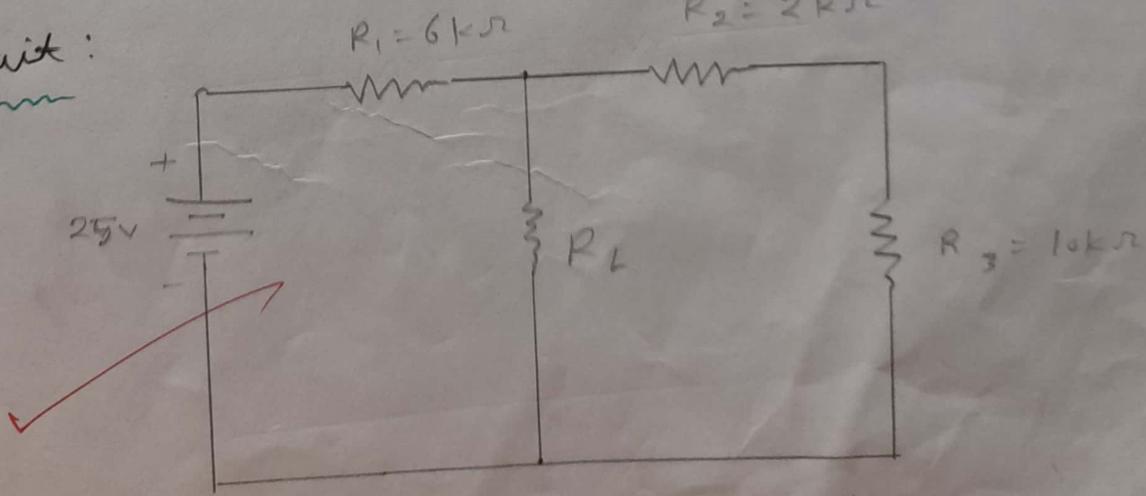


Fig: Experimental circuit.

Experimental table: Experimental table for Norton's Theorem

No of observation	R_L ($k\Omega$)	I_L (mA) calculated	I_L (mA) Measured	Error (%)
1	12	1.04	1.04	0%
2	22.56	0.636	0.63	0.6%
3	34.6	0.43	0.43	0%
4	40	0.378	0.38	0.5%
5	45	0.339	0.34	0.2%
6	47.8	0.32	0.32	0%
7	50	0.308	0.31	0.6%
8	60	0.26	0.26	0%
9	75	0.21	0.21	0%
10	80	0.198	0.20	1%

Result: From the table we get both the calculated and measured value of current.

From the equation, we get the value of R_N, I_N and I_L.

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

$$= \frac{(R_2 + R_3) \times R_1}{R_2 + R_3 + R_1}$$

$$= \frac{(2+10) \times 6}{2+10+6} = 4 k\Omega.$$

we know,

$$V = I_N R_1$$

$$\Rightarrow I_N = \frac{V}{R_1}$$

$$= \frac{25}{6}$$

$$\therefore I_N = 4.16\, mA$$

The load current, $I_L = I_N \times \frac{R_N}{R_N + R_L}$

$$= 4.16 \times \frac{4}{4+12} \quad [R_L = 12k\Omega]$$

$$= 1.04\, mA$$

Similarly we fill up the table.

Discussion: From the table and result we get almost same current from calculated and measured we get the Norton resistance R_N, Norton current I_N and load current I_L, we get some error.

Precaution: (i) We set up all the required componants on the breadboard with their required values.

(ii) ~~All~~ the connection should be jointed properly and carefully.

(iii) We measured the load current very carefully.

PABNA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department of
Information and Communication Engineering
Faculty of Engineering and Technology

LAB REPORT

Crouse Title : Circuit Theory and Analysis Sessional

Crouse Code : ICE - 1206

Experiment No : 06

Experiment Name : To study The Reciprocity Theoremn .

Submitted By :

Name : Joy Saha

Roll : 190635

Session : 2018 – 2019

1st year 2nd semister

Department of ICE , PUST

I C E I C E

Submitted To :

Sohag Sarker

Assistant Professor ;

Tarun Debnath

Lecturer;

Department of ICE , PUST

Signature ....

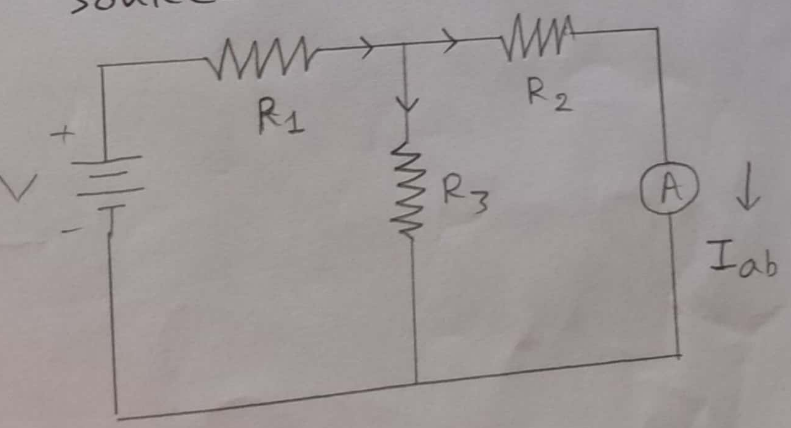
Experiment Name : To study the Reciprocity Theorem.

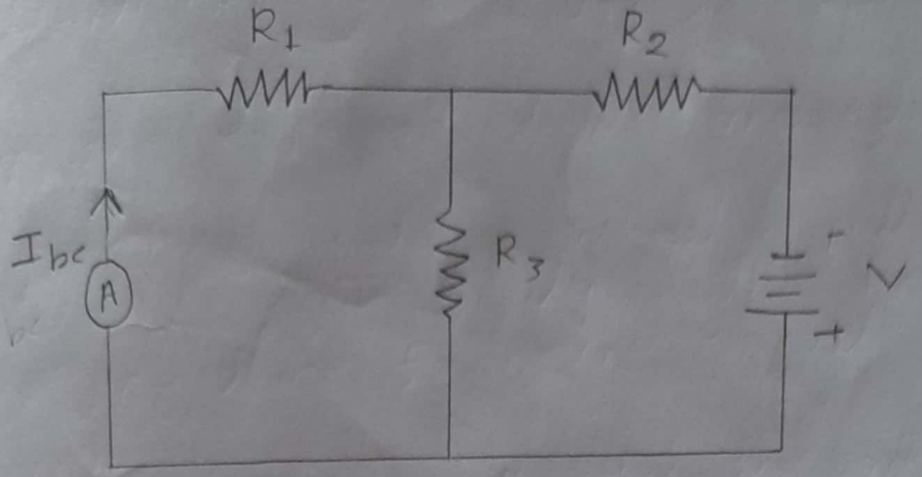
Objective : ① To analysis the Reciprocity theorem.

⑪ To determine the current from the circuit.

Theorey : It states that in a linear bilateral network if we interchange the position of source and zero resistance ammeter the current through the ammeter will be same.

The reciprocity theorem is applicable for single source network.





Demonstrating the impact of the reciprocal theorem. From figure,

$$R_{T_a} = \frac{R_2 \times R_3}{R_2 + R_3} + R_1 \qquad R_{T_b} = \frac{R_1 \times R_3}{R_1 + R_3} + R_2$$

$$I_{T_a} = \frac{V}{R_{T_a}} \qquad I_{T_b} = \frac{V}{R_{T_b}}$$

$$I_{ab} = \frac{R_3}{R_2 + R_3} \times I_{T_a} \qquad I_{bc} = \frac{R_3}{R_1 + R_3} \times I_{T_b}$$

Experimental Equipment:

(I) Breab board;

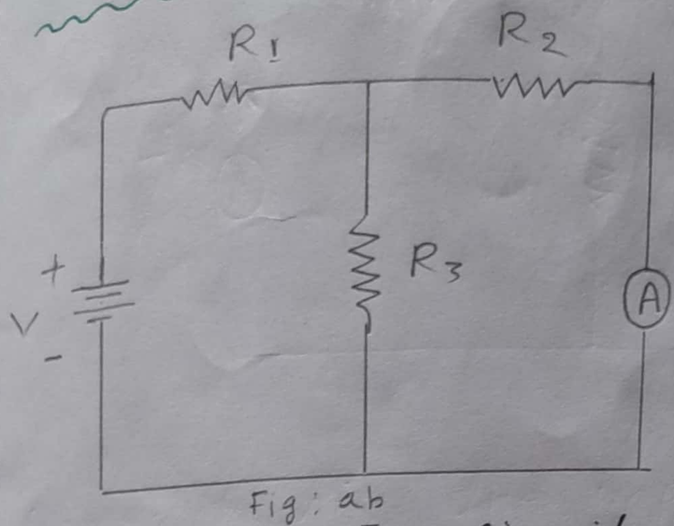
(II) Resistor;

(III) Avo meter;

(IV) Connecting wire;

(V) Supply voltage;

Experimental circuit :



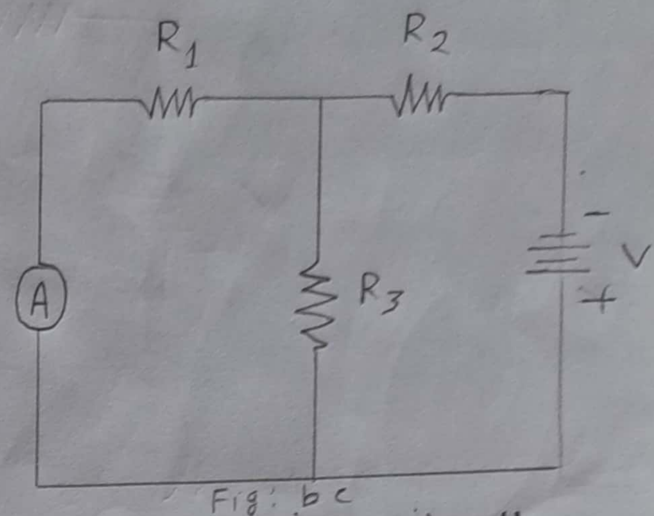


Fig: Circuit diagram for Reciprocity theorem

Experimental data table : Experimental data for reciprocity theorem.

No of observation	Supply voltage V(volt)	1st circuit		2nd circuit		Error %
		I_{ab} (cal) (A)	I_{ab} (mea) (A)	I_{bc} (cal) (A)	I_{bc} (mea) (A)	
01	3.32	0.22	0.17	0.22	0.16	5.88
02	4.85	0.32	0.26	0.32	0.26	0
03	5.64	0.37	0.30	0.37	0.30	0
04	6.23	0.41	0.34	0.41	0.34	0
05	7.05	0.46	0.39	0.46	0.39	0
06	8.12	0.53	0.46	0.53	0.45	2.17
07	9.20	0.60	0.52	0.60	0.53	1.87
08	10.40	0.68	0.59	0.68	0.59	0
09	11.69	0.77	0.67	0.77	0.67	0
10	12.63	0.83	0.73	0.83	0.73	0

Result and Discussion: From experimental data table we can saw that calculated and measured current where supply voltage is variable.

From figure ab,

$$R_{T_a} = \frac{R_2 \times R_3}{R_2 + R_3} + R_1 = \frac{4.19 \times 0.987}{4.19 + 0.987} + 2.1 = 2.90 k\Omega$$

$$I_{T_a} = \frac{V}{R_{T_a}} = \frac{3.32}{2.90} = 1.145 A \quad [\text{when } V = 3.32 V]$$

$$I_{ab} = \frac{R_3}{R_2 + R_3} \times I_{T_a} = \frac{0.987}{4.19 + 0.987} \times 1.145$$

$$= 0.22 A$$

From figure bc,

$$R_{T_b} = \frac{R_1 \times R_3}{R_1 + R_3} + R_2 = \frac{2.1 \times 0.987}{2.1 + 0.987} + 4.19 = 4.86 k\Omega$$

$$I_{T_b} = \frac{V}{R_{T_b}} = \frac{3.32}{4.86} = 0.68 A \quad [\text{when } V = 3.32 V]$$

$$I_{bc} = \frac{R_3}{R_1 + R_3} \times I_{T_b} = \frac{0.987}{2.1 + 0.987} \times 0.68$$

$$= 0.22 A.$$

We can notice that First circuit and 2nd circuit calculated current are same and measured current almost same.

Similarly, we can get other data on this processes.

Precaution: ① All the element should set up very tightly.

⑪ Measured current by the Avo meter very carefully.