

**Republic of Iraq**

**Ministry of Higher Education and Scientific Research**

**AL-Furat AL-Awsat Technical University – Iraq**



**Kerbela Polytechnic College**

**Department of Mechanical Engineering Technology**

**Fundamentals of Electricity**

# **Electricity laboratory experiments**

**By**

**Assist. Lectures**

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**MS.C Physics Science**

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**General Objective: To introduce students to electrical circuits and electrical measurements.**

**Specific Objective: To prepare students to study various calculations in alternating current (AC) and direct current (DC) circuits, to familiarize them with the different theories used in these calculations, and to introduce them to various measuring instruments.**

**Practical Objectives: To apply theoretical concepts through experiments on DC and AC circuits and to train students in the use of laboratory electrical equipment for various measurements.**

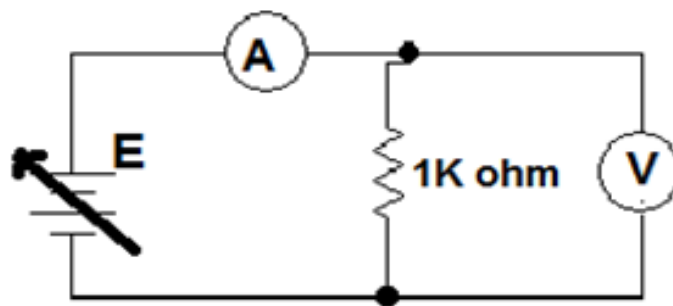
## The tools and equip



**Title Of Experiment: Calculation Ohms' law**

**Aim of Experiment: Practical realization of Ohm's law**

**Theory :The ratio of potential difference(v) between any point on a conductor to the current(I) flowing between them, is constant, provided the temperature of the conductor does not change  
 $V/I=\text{constant}=R$**



**fig(3-1)**

**Equipment and materials:**

- 1- D.c power source.**
- 2- Ammeter and voltmeter or avometer.**
- 3- Resistance (1 k)**
- 4- Wires.**

**Procedure:**

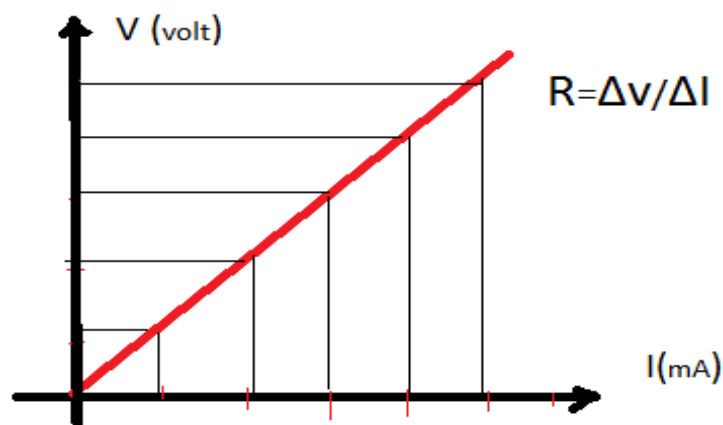
**1-Connect the cct. As shown in fig.(3-1).**

**2-Put the source voltage at 10 v for each step by 2 volt.**

**3-Measure the voltmeter and ammeter reading and tabulate as in the table.**

E	V	A	R=v/I
2 volt			
4			
6			
8			
10			

**Report: Represent the relationship between current and voltage from the table and calculate the resistance value from that curve.**



## **Title Of Experiment: Connecting resistors in series - parallel - mixed**

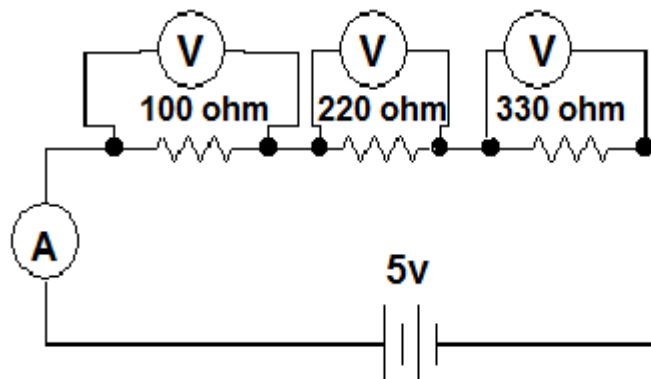
**Aim of Exp.: Valuation of equivalent resistance of series, parallel and mixed connection .**

**Theory: In series connection of resistance**

$$V_T = v_1 + v_2 + \dots + v_n \quad n = \text{no. of resistances in the cct.}$$

$$I_T = I_1 = I_2 = I_3 \dots = I_n$$

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



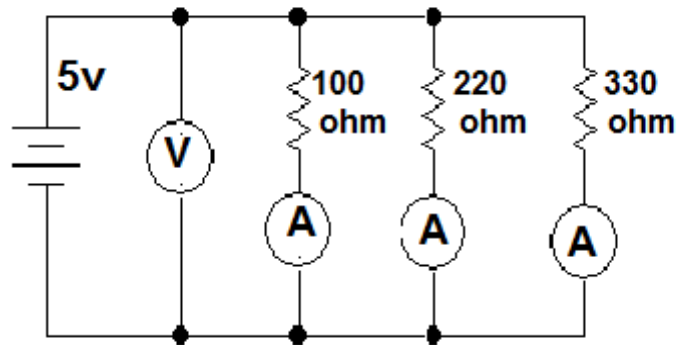
**FIG(4-1)**

**In Parallel connection of resistance**

$$V_T = v_1 = v_2 = \dots = v_n$$

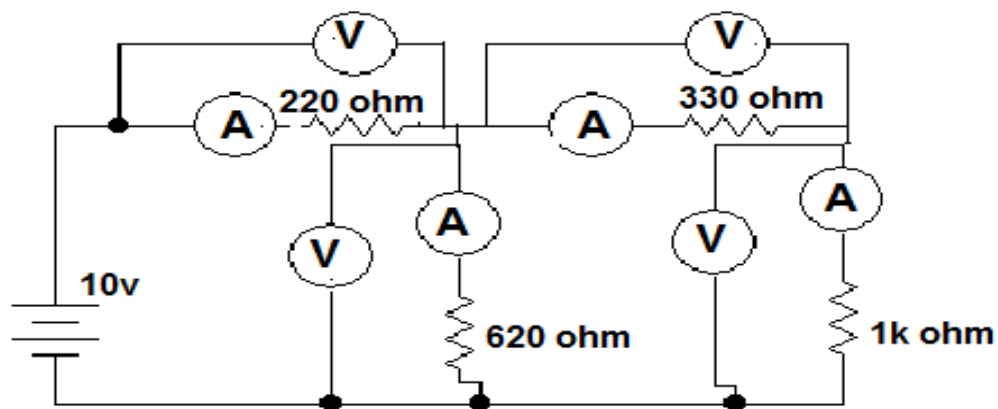
$$I_T = I_1 + I_2 + \dots + I_n$$

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



fig(4-2)

### Mix (series and parallel) connection



fig(4-3)

### Equipment and materials

- 1-D.c Power source .
- 2-Ameter and voltmeter.
- 3-Resistances ( $100\Omega$  ,  $220\Omega$  ,  $330\Omega$  ,  $220\Omega$  ,  $1k\Omega$  ,  $620\Omega$ ).
- 4-Wires.

### Procedure(1)

- 1-connect the cct. Shown in fig.(4-1).
- 2-Measure the volt at each resistance.
- 3-Measure the total current.

R				R			
V <sub>(volt)</sub>				V <sub>(volt)</sub>			
I <sub>(mA)</sub>				I <sub>(mA)</sub>			

The practical value

The theoretical value

$$I_T = E/R_T = 5/(100+220+330) = 7.6 \text{ mA}, \quad V_1 = I_T R_1 = 0.76 \text{ v},$$

$$V_2 = I_T R_2 = 7.6 \times 330 = 2.5 \text{ v}, \quad V_3 = I_T R_3 = 7.6 \times 330 = 2.5 \text{ v}$$

### Procedure(2)

- 1-connect the cct. Shown in fig.(4-2).
- 2-Measure the current on each resistance.
- 3-Measure the total voltage.

R					R			
V <sub>(v)</sub>					V <sub>(v)</sub>			
I <sub>(mA)</sub>					I <sub>(mA)</sub>			

The practical value

The theoretical value

$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 = 1/100 + 1/220 + 1/330 \quad \therefore R_T = 66.06 \Omega$$

$$I_1 = E/R_1 = 5/100 = 0.05 \text{ A} \quad I_2 = E/R_2 = 5/220 = 0.022 \text{ A}$$

$$I_3 = E/R_3 = 5/330 = 0.015 \text{ A} \quad I_T = 0.05 + 0.022 + 0.015 = 0.087 \text{ A}$$

$$V_T = I_T \times R_T = 0.087 \times 66.06 = 5.7 \text{ v}$$

### Procedure(3)

1-connect the cct. Shown in fig.(4-3).

2-Measure the current and voltage at each resistance.

R	220	620Ω	330 Ω	1k Ω		R	220	620Ω	330 Ω	1k Ω
V(v)						V(v)				
I(mA)						I(mA)				

The practical value

The theoretical value

$$R_T = [(330+1000) // 620] + 220 = 2622.87 \Omega = 2.623k \Omega$$

$$I_T = E/R_T = 10/2623 = 3.8mA, V_{220} = I_T \times R_{220} = 3.812 \times 220 = 8.38772v$$

$$I_{620} = I_T \times (330+1000)/(620+330+1000) = 2.6mA = 2.6 \times 10^{-3} A$$

$$V_{620} = 2.6 \times 620 = 1.612v \quad I_{330} = I_{1000} = 3.8 - 2.6 = 1.2126mA$$

$$V_{330} = 1.2 \times 10^{-3} \times 330 = 0.4006v, \quad V_{1000} = 1.2126 \times 10^{-3} \times 1000 = 1.2v$$

**Discussion:-** Calculate (I<sub>T</sub>,V<sub>T</sub>) in each case.

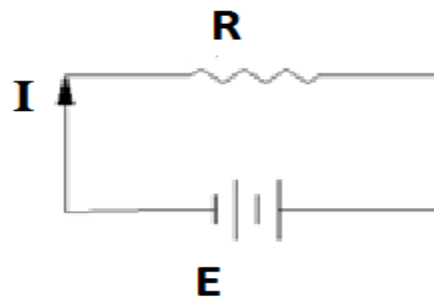
## Title Of Experiment: Kirchhoff's Laws

**Aim of Experiment: To prove Kirchhoff's Laws practically**

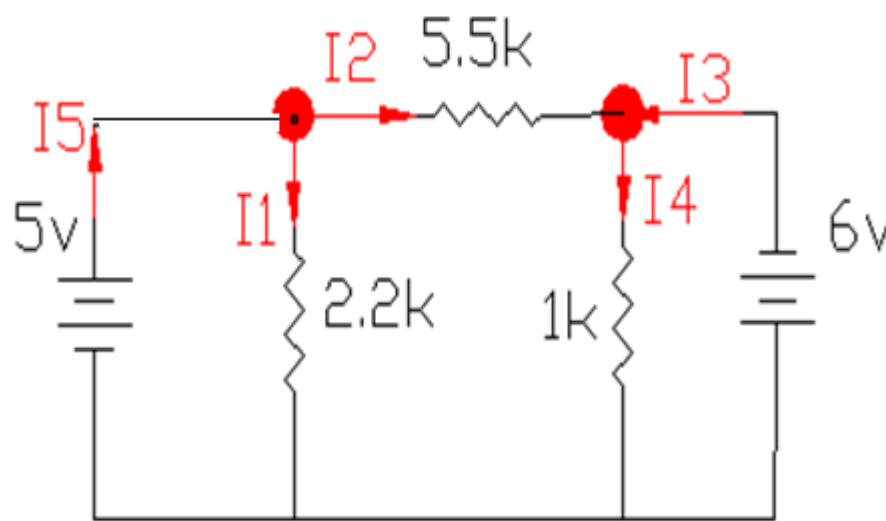
**Theory: The first law : At any electric point the algebraic sum of interring currents and outing current equal zero by using plus signal to interring current and mines signal to outing current.**

**$I_1+I_2+I_3=I_4+I_5+I..$  (First law)**

**The second law :In any closing cct. The algebraic sum active e.m.f. around the close cct. Equal the algebraic sum to the potential difference to the same circuit**



$$\Sigma E = \Sigma I.R \dots\dots\dots(\text{The second law})$$



**fig(6-1)**

### Equipment and materials:

- 1- Two D.c. power source.
- 2- Resistances ( $1\text{k}\Omega$ ,  $5.5\text{k}\Omega$ ,  $2.2\text{k}\Omega$ ).
- 3- Ammeter and voltmeter.
- 4- Wires.

### Procedure:

- 1-connect the cct. Shown in fig.(6-1).
- 2- Measure the current flows in each resistance by ammeter.
- 3- Read the voltage value across each resistance by voltmeter.

The current	$I_1$ mA	$I_2$ mA	$I_3$ mA	$I_4$ mA	$I_5$ mA
Measure value					
Calculate value					

The voltage (volt)	$V$ at $2.2\text{k}\Omega$	$V$ at $5.5\text{k}\Omega$	$V$ at $1\text{k}\Omega$
Measure value			
Calculate value			

### Discussion :

- 1- Calculate the current flows in each resistance theoretically .
  - 2- Find the voltage at each resistance.
- 

### Solution:

$$I_5 = I_1 + I_2 \dots (1)$$

$$I_3 = I_2 + I_4 \dots (2)$$

$$5 = 2.2 \times I_1 \dots (3)$$

$$I_1 = 2.7 \text{mA} \quad ; 6 = 1 \times I_4 \quad ; I_4 = 6 \text{mA}$$

$$0 = 2.2 \times I_1 + 1 \times I_4 - 5.5 \times I_2$$

$$0 = 2.2 \times 2.7 + 1 \times 6 - 5.5 \times I_2$$

$$\therefore I_2 = 11 / 5.5 = 2 \text{mA}$$

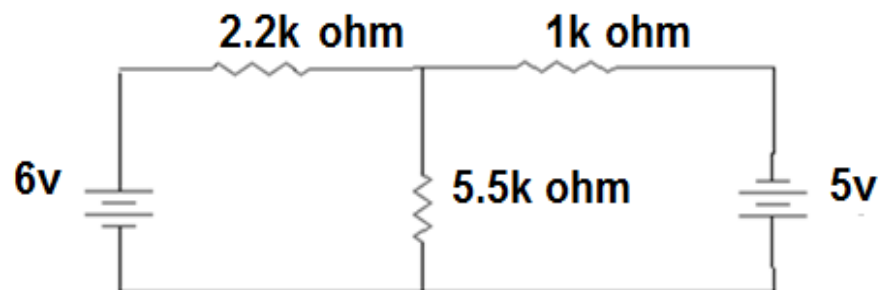
$$\therefore I_3 = 2 + 6 = 8 \text{mA}$$

$$\therefore I_5 = 2.7 + 2 = 4.7 \text{mA}$$

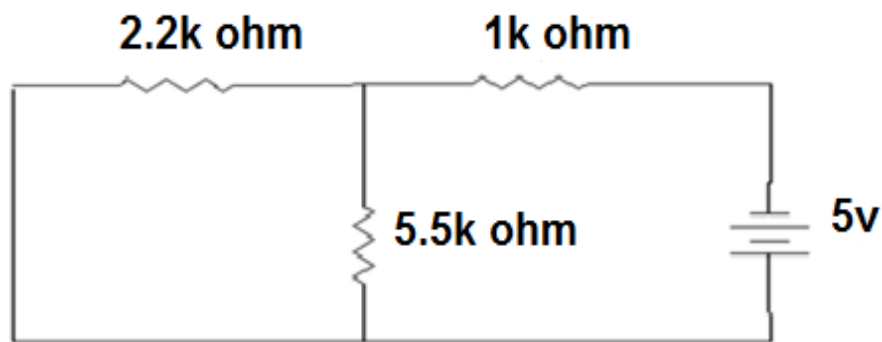
## Title Of Experiment: Superposition's theorem

**Aim of Experiment: To prove Superposition's theorem Practically**

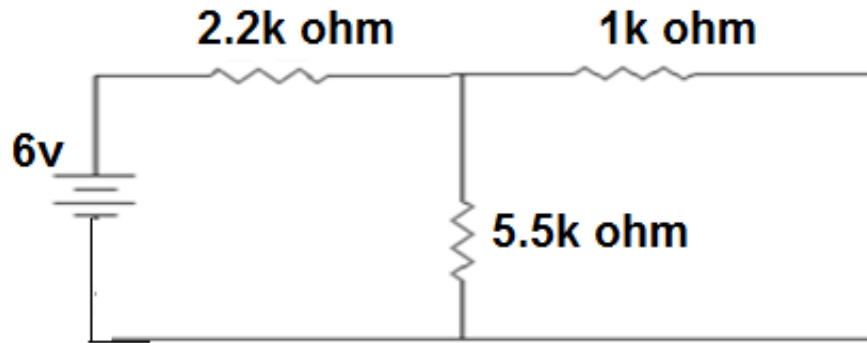
**Theory: In a network containing more than one source of e.m.f. the current which flows at any point is the sum of all the currents which flow at that point if each generator were considered separately and all the other source of e.m.f. are replaced by short cct. With internal resistance and the current source replaced by open cct.**



fig(9-1)



fig(9-2)



fig(9-3)

**Equipment and materials:**

- 1- D.c power source No(2)
- 2- Ammeter and voltmeter.
- 3- Resistances(2.2k,1k,5.5k)
- 4- Wires.

**Procedure:**

- 1- Connect the cct. Shown in fig. (9-1) Measure the current and p.d. for each resistance (2.2k,1k,5.5k).
- 2- Connect the cct. Shown in fig(9-2), Measure the current and p.d. for each resistance (2.2k,1k,5.5k).
- 3- Connect the cct. Shown in fig(9-3), Measure the current and p.d for each resistance (2.2k,1k5.5k).

R(k $\Omega$ )	V	I
2.2k		
1k		
5.5k		

R(k $\Omega$ )	V	I
2.2k		
1k		
5.5k		

R(k $\Omega$ )	V	I
2.2k		
1k		
5.5k		

Case(1)  
case(2)

case(2)

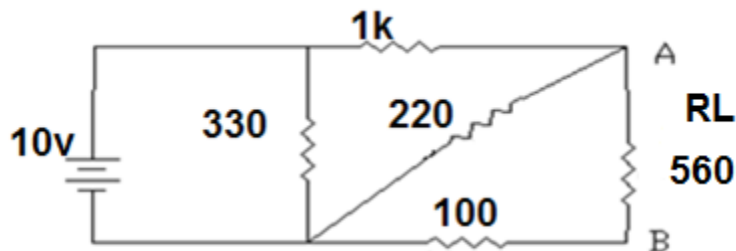
**Discussion:** Calculate (IL) theoretically

## Title Of Experiment: Thevenin's theory

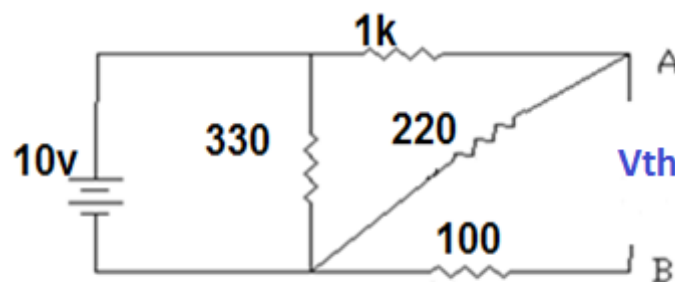
**Aim of Experiment: To prove Thevenin's theory practically**

**Theory: The flows current in a resistance connected to the ends of work equal to the current flows in a resistance connected to voltage supply if:**

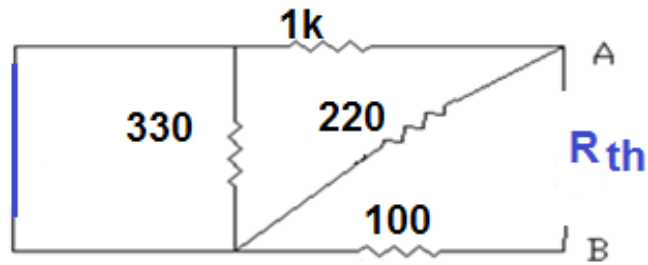
- 1- The e.m.f. to the source ( $v_{th}$ ) equal to the voltage of the open cct. At the ends of a resistance .
- 2- Internal resistance of the source ( $r_s$ ) equal to the network resistance appears at the end of resistance after compensating of the source voltage by short cct. And source current by open cct.



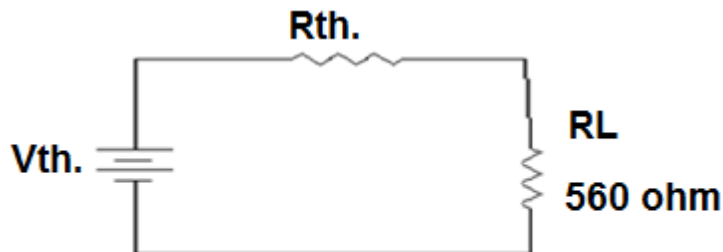
fig(7-1)



fig(7-2)



fig(7-3)



fig(7-4)

### Equipment and materials;

- 1- D.c power source .
- 2-Resistances( 1k,330 $\Omega$ ,220 $\Omega$ ,100 $\Omega$ ,560 $\Omega$ ).
- 3-wirs.

### Procedure:

- 1- connect the cct. Shown in fig.(7-1).
- 2- Read the three current ( $I_L$ ) in the resistance (560) between A,B and voltage( $V_L$ ) a cross the Sam resistance.
- 3- Remove  $R_L$ , from the cct. As shown in figure (7-2) .
- 4- Measure the potential difference between point A and B This p.d represent ( $V_{th}$ )
- 5- Remove voltage source as shown in fig. (7-3)and replace it by short cct
- 6- Measure the resistanc between points **A** and **B** which represent ( $R_{th}$ )

7- Connect the cct. Shown in fig. (7-4) by using the value which you have (**V<sub>th</sub>**,**R<sub>th</sub>**).

8- Measure the (**I<sub>L</sub>**) and (**V<sub>L</sub>**) through (**R<sub>L</sub>**).

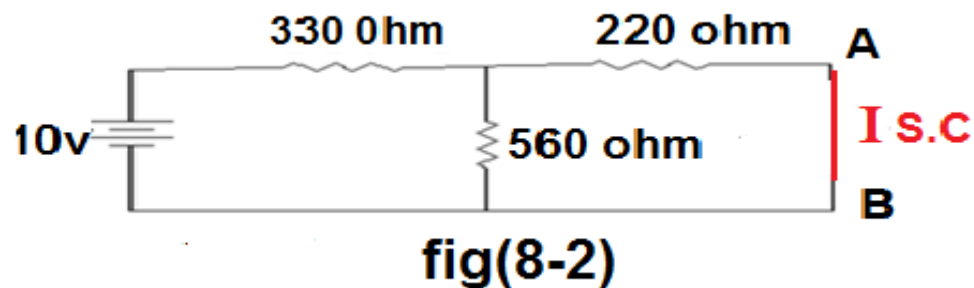
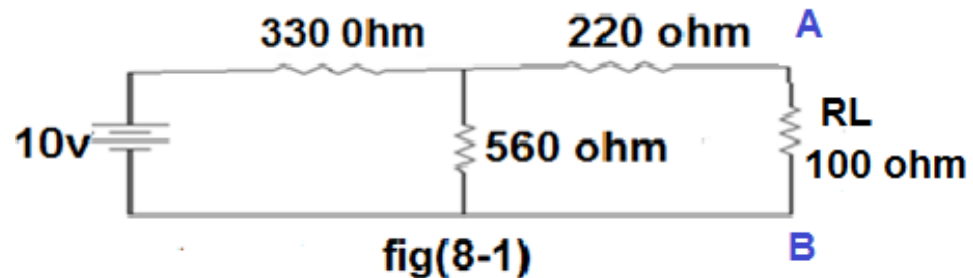
R <sub>th</sub> =560Ω	V <sub>th</sub> (v)	R <sub>th</sub> (Ω)	V <sub>RL</sub> (v)	I <sub>RL</sub> (mA)
Measure value				
Calculate value				

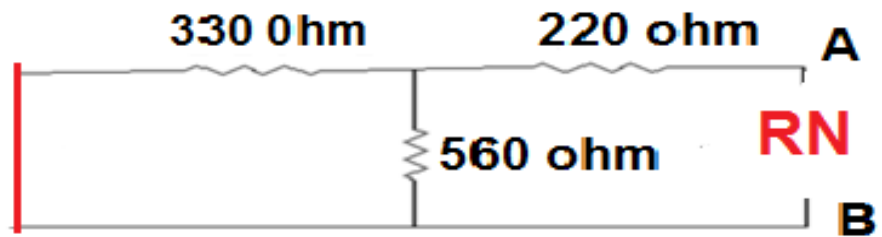
**Discussion:** Calculate (I<sub>L</sub>) theoretically

## Title Of Experiment: Norton's theory

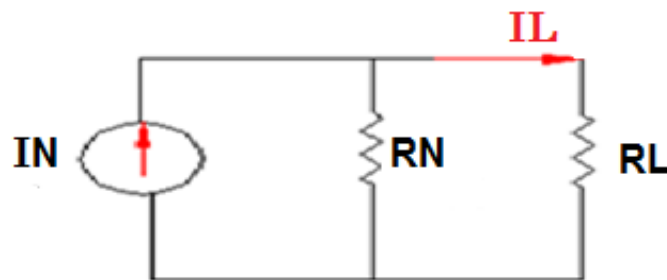
**Aim of Experiment: To prove Norton's theory Practically**

**Theory: When open branch in a circuit them represent the remaining of the circuit by source current in parallel with resistance. The Value of source current equal to the current passing in short circuit across the branch and the internal resistance equal to the appertains resistance across the ends of the branch after compensating voltage source by short circuit and current source by open circuit.**





fig(8-3)



fig(8-4)

$$I_L = I_N (R_N) / (R_N + R_L)$$

**Equipment and materials:**

- 1- D.c power source.
- 2- Resistances (330Ω , 560Ω , 220Ω , 100Ω ).
- 3- Wires.
- 4- Ammeter and Voltmeter.

**Procedure:**

- 1-Connect the cct. Shown in fig. (8-1).
- 2-Measure the current flows (**IL**) in **RL** and (**VL**) between A and B.
- 3- Remove the **RL** from the cct. and measure the **Is.c.** As shown in fig.(8-2).
- 4- Remove voltage source as shown in fig.(8-3) and replace it by short cct and measure **RN**
- 5- Connect the Norton cct. Shown in fig.(8-4)by using the values (**Is.c.** and **RN**) in parallel with **RL** .
- 6- Measure the (**VL** )and (**IL**) between (A and B).

RL(100Ω)	Is.c (mA)	RN	IL	VL (v)
Measure value				
Calculate value				

**Discussion:** Calculate (**IL**) theoretically .

## Title Of Experiment: Star(Y) and Delta ( $\Delta$ ) Connection

**Aim of Exp.: To Prove the equivalent circuit between star and delta connections.**

**Theory:**

Change Y to  $\Delta$ :

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

$$R_a = (220 \times 560 + 560 \times 560 + 560 \times 220) / 560 = 560000 / 560 = 1000 \Omega$$

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

$$(220 \times 560 + 560 \times 560 + 560 \times 220) / 560 = 560000 / 560 = 1000 \Omega$$

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

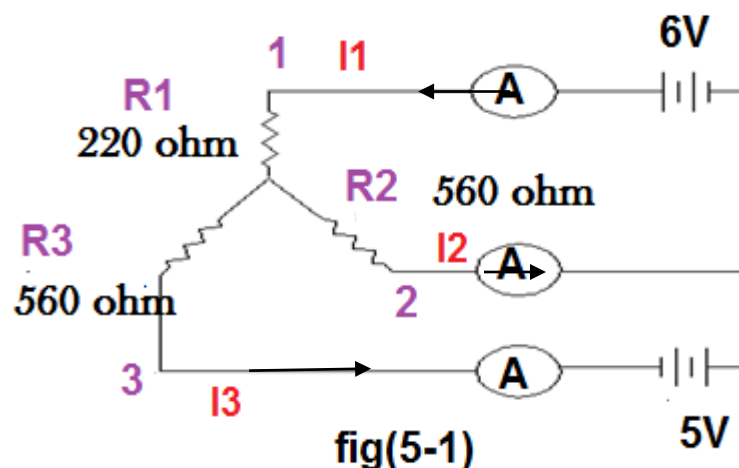
$$(220 \times 560 + 560 \times 560 + 560 \times 220) / 220 = 560000 / 220 = 250 \Omega$$

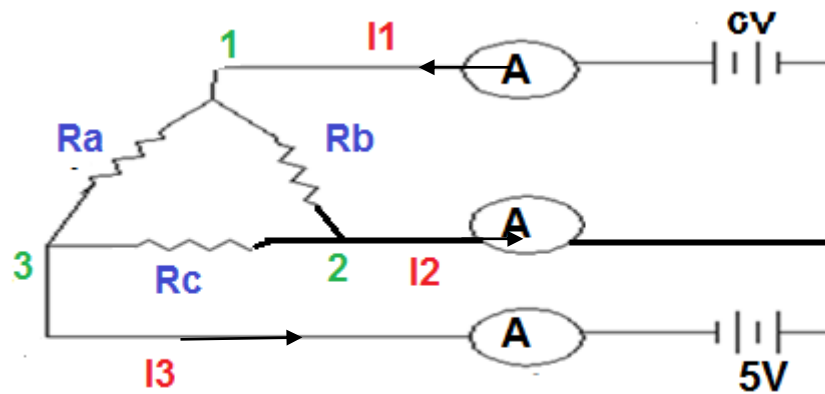
Change  $\Delta$  to Y:

$$R_1 = R_a.R_b / (R_a + R_b + R_c)$$

$$R_2 = R_b.R_c / (R_a + R_b + R_c)$$

$$R_3 = R_a.R_c / (R_a + R_b + R_c)$$





fig(5-2)

### Equipment and materials :

- 1- Two D.c Power sources .
- 2- Three Ammeters one to each line .
- 3- Resistances ( $220 \Omega$ ,  $560 \Omega$ ,  $560 \Omega$ .)
- 4- Wires.

### Procedure(1)

- 1- connect the cct. Shown in fig.(5 -1).
- 2- Read the three Ammeters reading .
- 3- Calculate the equivalent resistances for the delta connection (Theoretically).

## Procedure(2)

4- Connect the circuit shown in fig. (5 -2) Using the values of resistances witch calculated from step (3).

5- Read the three Ammeters reading.

$I_{mA}$	$I_1$	$I_2$	$I_3$		$I_{mA}$	$I_1$	$I_2$	$I_3$

*Tablet from -Y-*

*Tablet from - $\Delta$ -*

**Discussion:** Calculate Line current in each case (Y and  $\Delta$ ).