B. Sc. Electronics (Hon’s) Ist Semester (Minor)
Basic Circuit Theory and Network Analysis (BCTN) Lab

List of Experiments

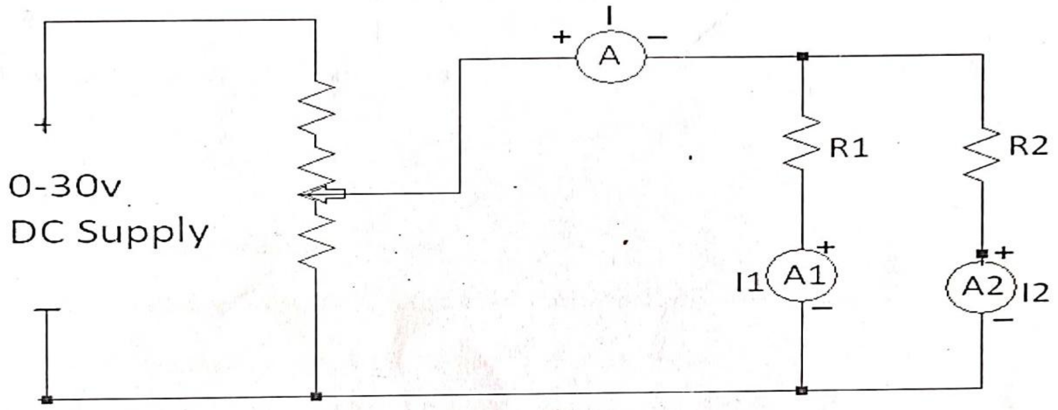
1. To verify Kirchhoff's Law.
2. To verify Norton’s theorem.
3. Verification of maximum power transfer theorem.
4. To verify Thevenin’s theorem.

Experiment No.-01

Aim: To verify Kirchhoff's Current Law (KCL).

Apparatus Required: DC power supply, 3 DC ammeters, 2 Rheostat, Multimeter, Connecting wires.

Circuit Diagram:



Observation Table:

S.No.	Current (mA)			$I' = I_1+I_2$	% Error= $(I-I')/I*100$
	I	I_1	I_2		

Theory: It states that the sum of current entering a junction is equal to the sum of current leaving the junction.

According to KCL,

$I = I_1 + I_2 + I_3 + I_4$, $\sum I = 0$. $\sum$=Summation,

Algebraic sum of current at a junction of a network is zero.

Procedure:

1. Connect the circuit as shown in the diagram.

2. Switch on the DC power supply.

3. By varying the voltage supply, take the reading of I_1, I_2 & I.

4. Repeat the same procedure for different observations.

5. Measure the value of R_1 and R_2 using Multimeter.

6. Calculate percentage error.

Result: The KCL has been verified.

Precaution:

1. Make the connections properly.

2. Note the readings of voltmeters and ammeters properly avoid parallax.

3. Connect the DC supply and ammeter with correct polarity.

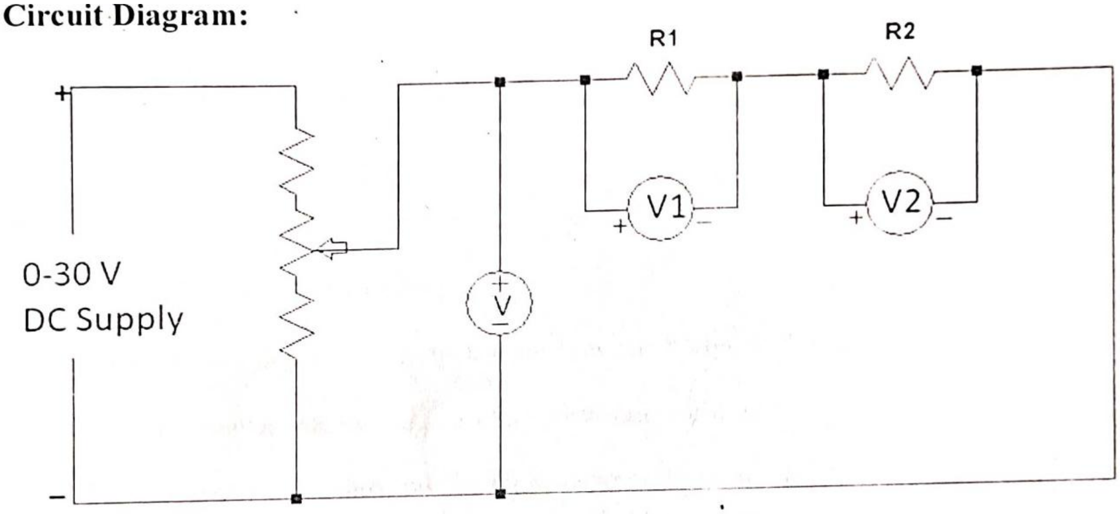
4. Avoid loose connection and don't touch wire with wet hand.

Aim: To verify Kirchhoff's Voltage Law (KVL).

Apparatus Required: DC power supply, 3 DC ammeters, 2 Rheostat, Multimeter, Connecting wires.

Circuit Diagram:

Circuit Diagram:



Observation Table:

S.No.	Voltage (V)			V'= V_1+V_2	% Error= (V-V')/V*100
	V	V_1	V_2		

Theory: It state that algebraic sum of voltage in a closed circuit is equal to zero.

$$\sum IR + \sum E.M.F. = 0$$

Procedure:

1. Connect the circuit as shown in the diagram.
2. Switch on the DC power supply.
3. By varying the voltage supply, take the reading of V_1, V_2 & V.
4. Repeat the same procedure for different observations.
5. Measure the value of R_1 and R_2 using Multimeter.
6. Calculate percentage error.

Result: The KVL has been verified.

Precaution:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly avoid parallax.
3. Connect the DC supply and ammeter with correct polarity.
4. Avoid loose connection and don't touch wire with wet hand.

Experiment No.-02

Aim: To verify Norton’s theorem.

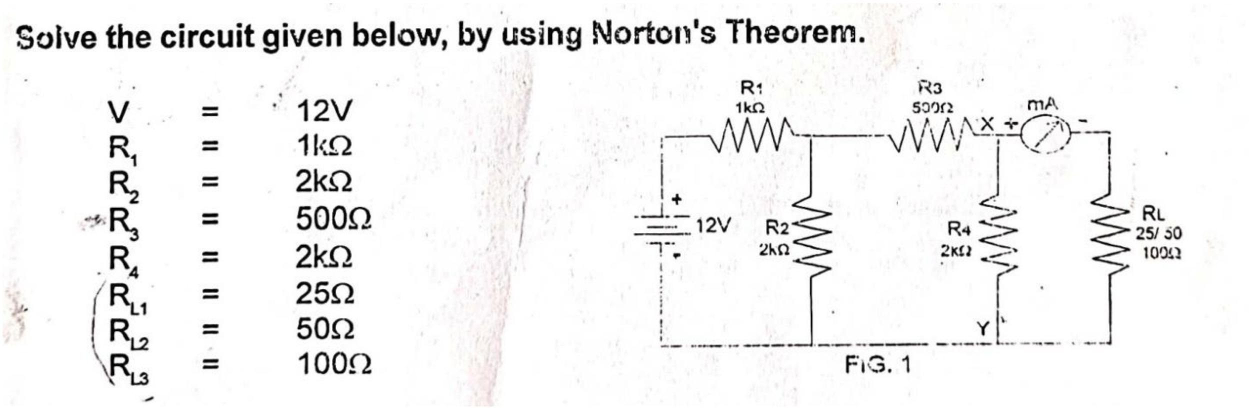
The instrument comprises of the following built in parts:-

1. DC regulated power supply of 12V.
2. Two meters are mounted on the front panel to measure the value of voltages and currents.
3. Different types of resistances are also mounted behind the front panel.
4. Circuit diagram for Norton's theorem is printed on the front panel.

THEORY

Any linear bilateral network containing one or more voltage sources can be replaced by an equivalent circuit consists of current source (I_{sc}) in parallel with resistance (R_{nor}). The I_{sc} is the short circuited current flowing through the output terminals and is the resistance measured across the output terminals with all the sources replaced by load resistance.

PROCEDURE



Solve the circuit given below, by using Norton's Theorem.

V = 12V
R_1 = 1kΩ
R_2 = 2kΩ
R_3 = 500Ω
R_4 = 2kΩ
R_{L1} = 25Ω
R_{L2} = 50Ω
R_{L3} = 100Ω

FIG. 1

Step 1:-

Open load and measure voltage and X & Y as shown in figure.

Open circuit voltage across R_4 = 5V (measured)

Step2:-

Now disconnect voltage sources and short through as shown in the diagram fig. no.3 (with R_L open circuit)

Now measure the resistance at X & Y

R_{nor} = 1 kΩ × 2 kΩ/ 3 kΩ =666Ω

=666Ω + 500Ω||2kΩ

=1.16kΩ ×2kΩ/1.18kΩ + 2kΩ

=2.33kΩ^2 /3.16kΩ = 737Ω

R_{nor}= 737Ω

Short circuit current

$I_{nor} = I_{sc} = V_{nor}/R_{nor}$

I_{sc} = 5/737Ω

I_{sc}= 6.78 mA

Now the circuit may be replaced as

I_{sc} = 6.78 mA

R_{nor} = 737Ω

For R_L = 25Ω

I_L = 6.78× 737/737 +25 = 6.55 mA

For R_L = 50 Ω

I_L = 6.78×737/737 +50 = 6.34 mA

For R_L = 100Ω

I_L = 6.78×737/737 +100 = 5.94 mA

Compare the calculated values with observed value

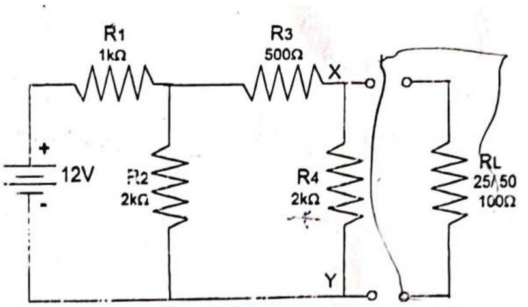


FIG. 2

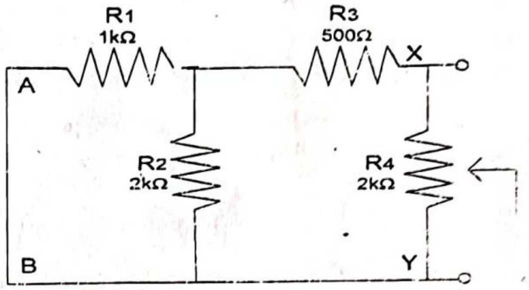
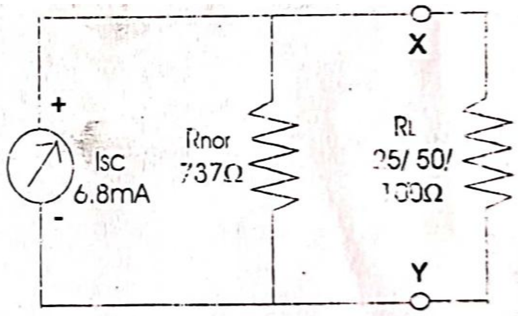


FIG. 3



Equivalent Circuit FIG NO. 4

Experiment No. 03

Aim: Verification of maximum power transfer theorem.

Apparatus required: 1. Fixed output DC regulated power supply of +12V.

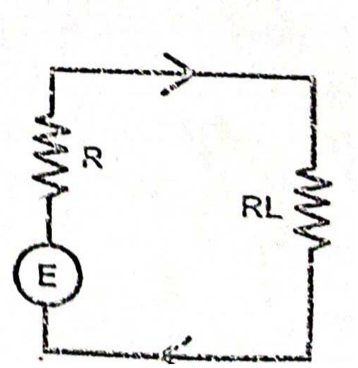
2. Variable resistance V_R (potentiometer), is mounted on the front panel.
3. Voltmeter and ammeter.
4. Three resistors R (50Ω, 100Ω, 150Ω).

Theory: When load is connected across a voltage source, power is transferred from the source to the load. The amount of power transferred will depend upon the load resistance. If load resistance is made equal to the internal resistance R_i of the source, then maximum power is transferred to the load R_L. This is known as the maximum power transfer theorem and can be stated as follows.

"Maximum power is transferred from a source to a load when the load resistance is made equal to the internal resistance of the source". This applies to DC as well as AC power.

To prove this theorem mathematically, consider a voltage source with voltage E and internal resistance R_i and delivering power to the load resistance R_L as shown in figure (1a). The current flowing through the circuit is given by

$$I = E/R_L + R_i$$



Power consumed to the load.

$P = I^2R_L = [E/R_i + R_L]^2\, R_L$ ------------------------(i)

For a given source, generated voltage E and internal resistance R_i are constant. Therefore, the power delivered to the load depends upon R_L. in order to find the value of $R_L$for which the value of P is maximum, it is necessary to differentiate eq. (i) w.r.t R_L and set the result equal to zero.

Thus

$dP/dR_L= [E^2(R_L + R_i) – 2R_L\,(R_L + R_i)] / (R_L + R_i)^4 = 0$

or $(R_L + R_i)^2 – 2R_L\,(R_L + R_i) = 0$

or $(R_L + R_i)\,(R_L + R_i – 2R_L) = 0$

or $(R_L + R_i)\,(R_i – R_L) = 0$

Since ($R_L + R_i$) cannot be zero.

So $R_i - R_L = 0$

or $R_L = R_i$

i.e. load resistance = internal resistance.

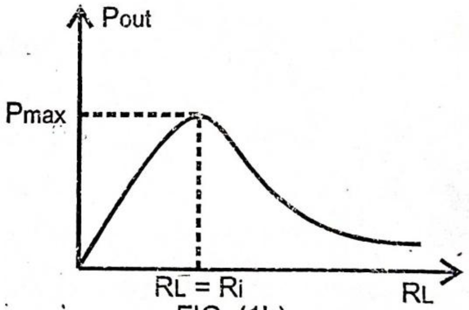


FIG. (1b)

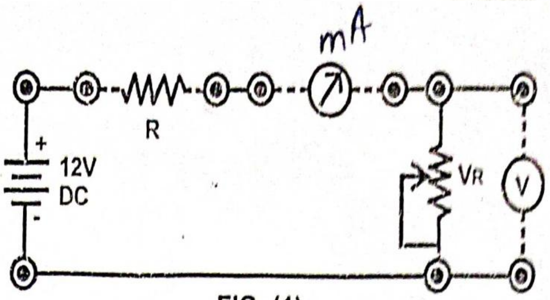


FIG. (1)

Thus, for maximum power transfer, load resistance R_L must be equal to the internal resistance R_i of the source. Under such conditions, the load is said to be matched to the source, fig. (1b) shows a graph of power delivered to R_L as a function of R_i. It may be mentioned that efficiency of maximum power transfer is 50% as one half of the total generated power is dissipated in the internal resistance R_i of the source.

Procedure:

1. Connect the DC power supply in the circuit as shown in fig. (1).
2. Connect R in the circuit and also connect the ammeter and voltmeter in the circuit.
3. Now increase the value of load resistance (VR) in steps and note down the corresponding value of voltage and current. Calculate the power formula :

   $$P = V \times I.$$

4. At a particular point when load resistance is made equal to the value of R (i.e. internal resistance of a source) maximum power is transferred from source to load. Draw a graph between power output and load resistance. It will be approximately similar to fig. (1b).
5. Repeat the steps 2-4 for other values of R.

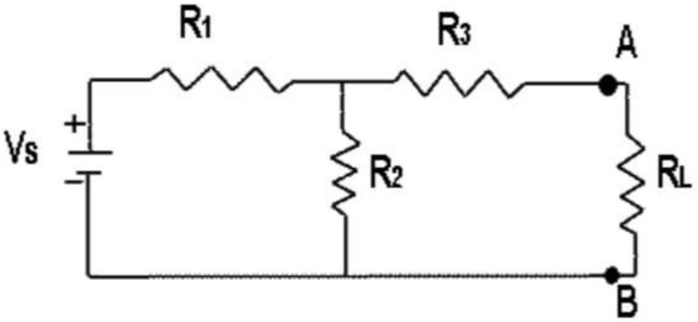
Experiment No. 04

Aim: To Verify the Thevenin's Theorem.

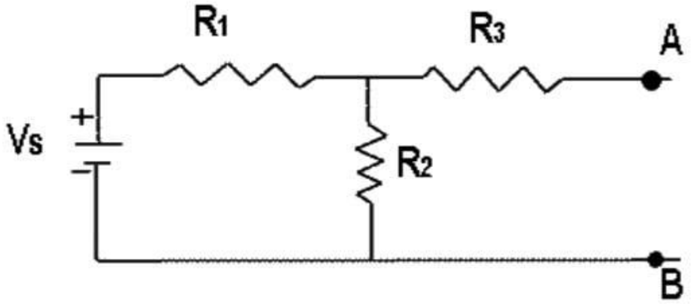
Theory: Thevenin's theorem states that it is possible to simplify any linear circuit, irrespective of how complex it is, to an equivalent circuit with a single voltage source and a series resistance.

In other words, any linear electrical network containing only voltage source, current source and resistances can be replaced at terminals A – B by an equivalent combination of a voltage source V_{th} in a series connection with a resistance R_{TH}.

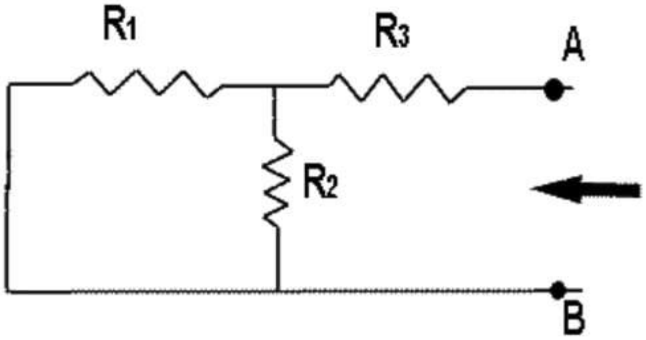
- (V_{TH}) the equivalent voltage V_{th} is the voltage obtained at terminal A-B of the network with terminals A-B open circuited.
- (R_{TH}) the equivalent resistance R_{th} is the resistance that the circuit between terminals A & B would have it all ideal voltage sources in the circuit.



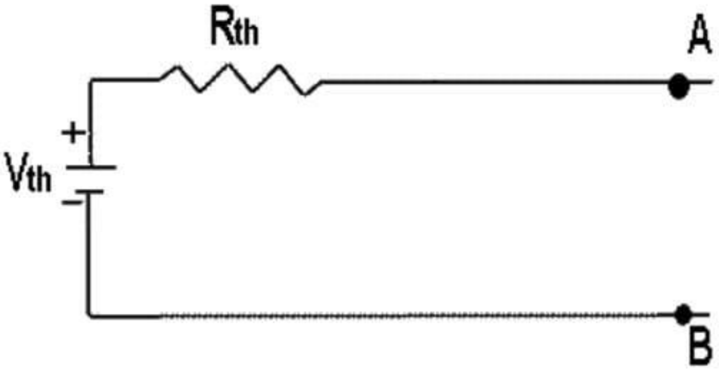
Thevenin's theorem circuit diagram



Thevenin's theorem circuit step 1



Thevenin’s theorem circuit step 3



Thevenin’s theorem circuit step 4

Step of process:-

I. Remove that resistance in which current is wanted.
II. Find the open circuit Voltage, called Thevenin’s equivalent voltage, V_{th}.

$$V_2 = V_S \frac{R_2}{R_1 + R_2}$$

$$V_{th} = V_S \frac{R_2}{R_1 + R_2}$$

III. Find the total resistance, from open terminals A and B side is called Thevenin's equivalent resistance, R_{th} removing actual voltage source from the circuit.

$$R_{th} = R_3 + R_1//R_2$$

$$R_{th} = R_3 + \frac{R_1 \times R_2}{R_1 + R_2}$$

IV. Connect V_{th} and R_{th} in series. This will be the Thevenin's equivalent circuit.

V. Reconnect the between the open terminals of the Thevenin's of the Thevenin's equivalent circuit.

VI. Find the current in R_L

$$I_L = \frac{V_{th}}{R_L}$$

As both resistances are connected in series so the in R_L and R_{th} are same.

TABLE – 1

(Calculated value)

S.N.	I_L	V_{TH}	R_{TH}	R_L
1.				
2.				
3.				

(NOTE: First find value using appropriate formulas)

TABLE – 2

(Experimental value)

S.N.	I_L	V_{TH}	R_{TH}	R_L
1.				
2.				
3.				

(NOTE: Value obtained from experiment)

Results:

Due to this experiment, we calculated V_{th} and R_{th} relation for equivalent circuit. The value of a resistance must remain constant. The output voltage of the power supply should remain constant while taking the date for the $V_L – I_L$ plot.

After comparing the theoretically and measured values we found that there are some changes with the values. This change is occurred by instruments.

Precautions:

- Take the readings without parallel error.
- Set the ammeter pointers at zero position.
- Avoid short circuit of RPS output terminals