LABORATORY MANUAL
B.SC. I SEMESTER
(ELECTRONICS)

Department of Pure & Applied Physics

Guru Ghasidas Vishwavidyalaya

(A Central University)

LIST OF EXPERIMENTS:

1. To Verify the Thevenin’s Theorem

2.To Verify the Norton’s Theorem

3.To Verify the Kirchhoff’s Laws

4. To Verify the Maximum Power Transfer

Theorem

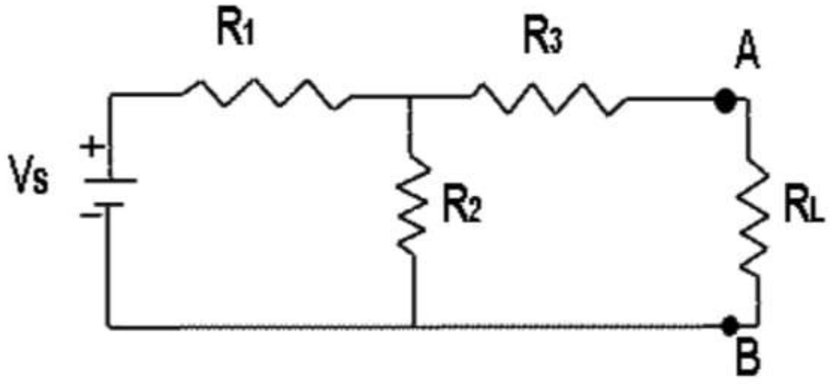
THEVENIN'S THEOREM

Aim:- To Verify the Thevenin's Theorem

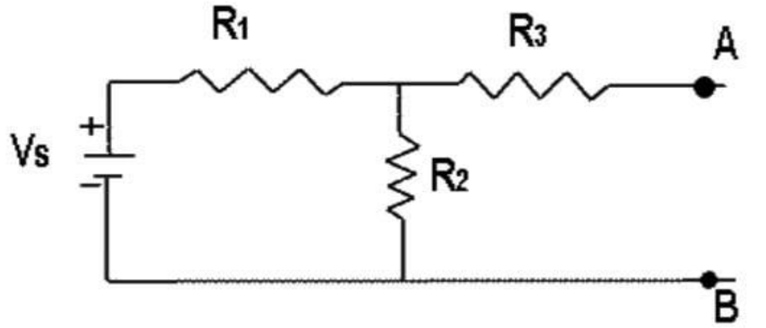
Theory : Thevenin's theorem states that it is possible to simplify any linear circuit, irrespective of how complex it is ,to an equivalent circuit with a single voltage source and a series resistance .

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 $\mathbf{R_{TH}}$.

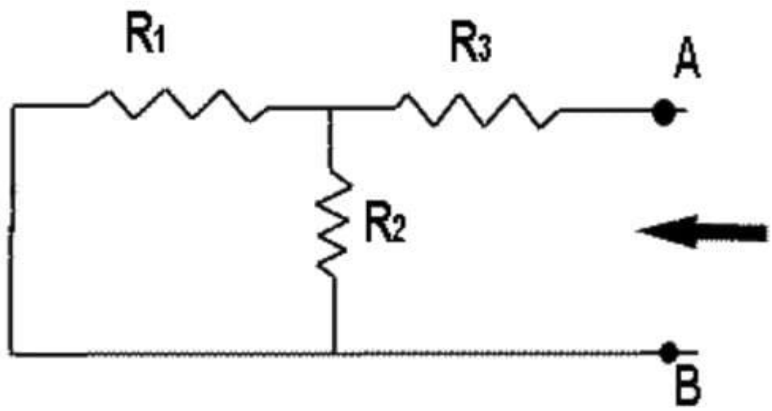
- ($\mathbf{V_{TH}}$) the equivalent voltage v_{th} is the voltage obtained at terminal A-B of the network with terminals A-B open circuited.
- ($\mathbf{R_{TH}}$) the equivalent resistance R_{th} is the resistance tha the circuit between terminals A&B would have it all ideal voltage sources in the circuit.



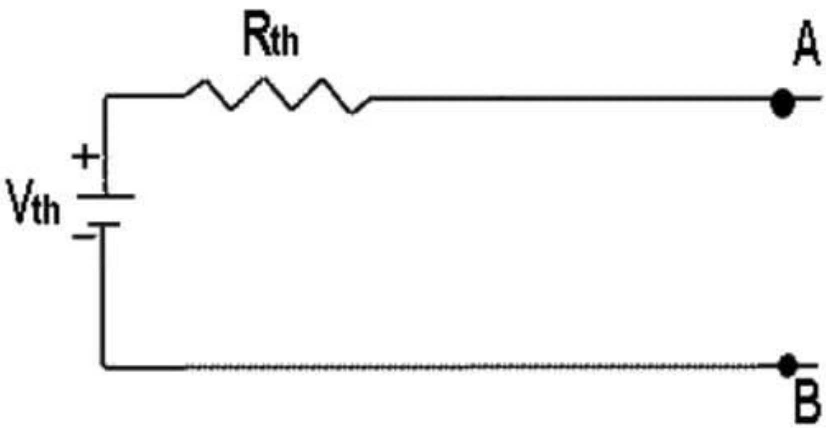
Thevenin’s theorem circuit diagram



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.

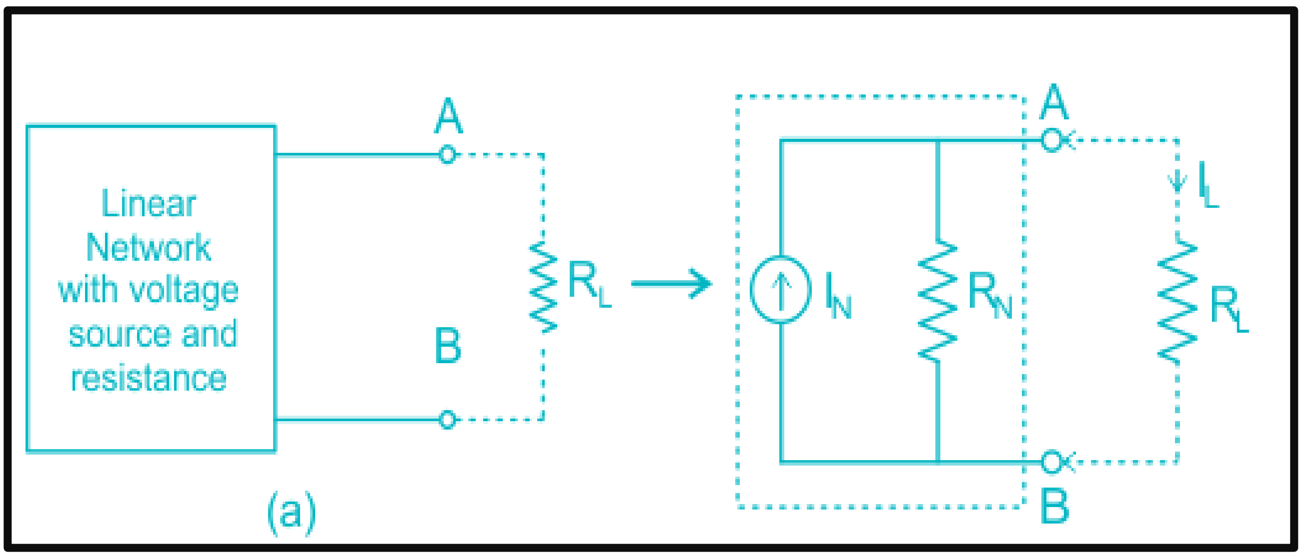
Precautions -:

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

NORTON'S THEOREM

Aim: To Verify the Norton's Theorem

Norton's theorem states that any 2-terminal linear and bilateral network or circuit having multiple independent and dependent sources can be represented in a simplified equivalent circuit known as Norton's equivalent circuit.

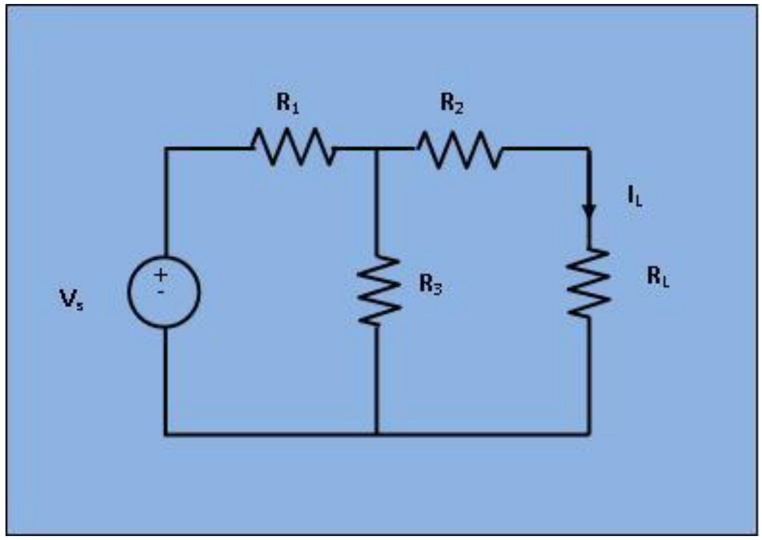


Norton's equivalent circuit consists of Norton's current source I_N in parallel with Norton's resistance R_N. The parallel combination of current source and resistor is a practical current source. Hence, we can say that Norton's equivalent circuit is nothing but a practical current source.

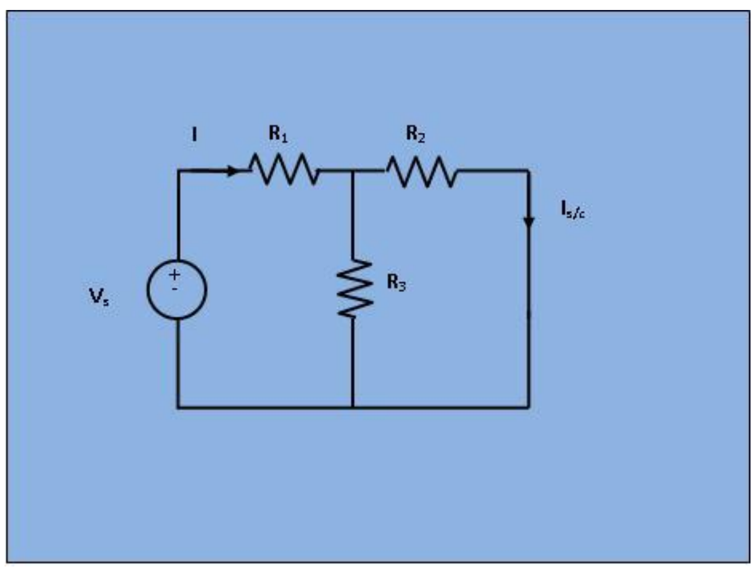
PROCEDURE TO FIND NORTON'S CURRENT:-

Calculate Norton Current

1. Remove the load resistance R_L (through which the current is required) and short circuit it. Let terminals of load are labelled as a-b. Therefore a-b is short circuited.



2. Find the current through the terminal a-b by applying KVL. KCL, Ohm's Law or Superposition principle. This Current is the short circuit current and it is known as Norton's equivalent current (I_N).



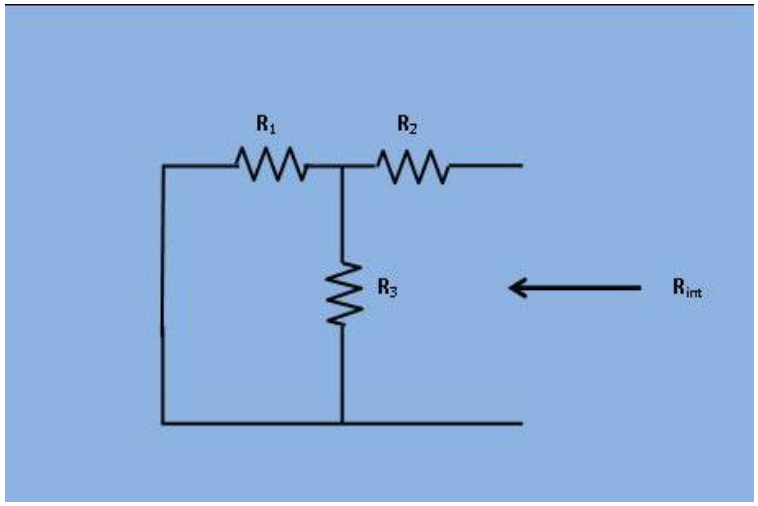
Calculate Norton Resistance (equal to Thevenin resistance)

3. Set all Independent voltages Sources as short circuit and Current Sources open circuit. Dependent sources will not be changed.

4. Calculate the resistance as "seen" through the terminals a-b into the network the resistance is known as Norton's equivalent resistance (R_N).

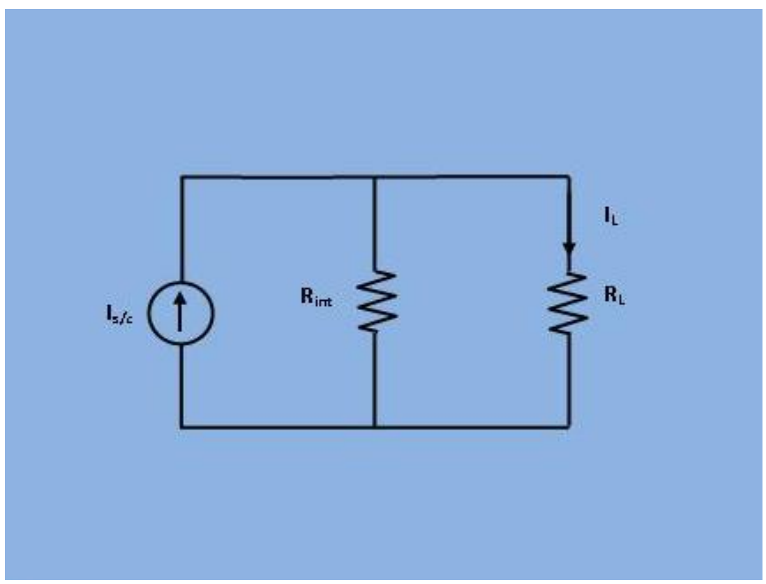
$R_N = R_3 + [1/ (1/R_1 + 1/R_2)]$

$R_N = R_3 + (R_1 \times R_2 / R_1 + R_2)$



Draw Equivalent Circuit

5. Replace the entire network by Norton's equivalent current (I_N) in parallel with Norton's equivalent resistance (R_{int}) and connect the load resistance R_L.



To Find current through load resistance

$I_L = I_{s/c} \times (R_{int} / R_{int} + R_L)$

Table for calculated value:-

Serial No.	I_L	$I_{s/c}$	R_{int}	R_L
1.				
2.				
3.				

Table for experimental value:-

Serial No.	I_L'	$I_{s/c}$	R_{int}	R_L
1.				
2.				
3.				

Result:-

The current I_L and R_L measured and calculated in the table 1 and 2 are equal for the same value of I_N.

Precautions:-

- To measure In the load R_L, should be removed for each time.
- The R_N computed should be nearly equal to the measured R_N value.

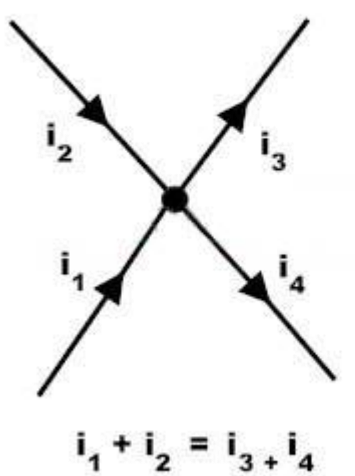
Kirchhoff's Law

Aim: To Verify the Kirchhoff's Laws

Theory: Many of the electrical circuits are complex in nature and the computations required to find the unknown quantities in such circuits, using simple ohm's law and series/parallel combination simplifying methods is not possible. Therefore, in order to simplify these circuits Kirchhoff's laws are used.

Kirchhoff's Current Law (KCL)

It states that the algebraic sum of currents at any node is zero. Thus the current entering at a node must be equal to sum of current out of the node.



$$I1 + I2 + (-I3) + (-I4) = 0$$

$$I1 + I2 = I3 + I4$$

Procedures :

1. Connect the circuit in the trainer kit as per the circuit diagram.
2. Adjust the input voltage by adjuster for different reading.
3. Connect the ammeters to get the respective currents meeting at the required node.
4. Repeat the same procedure for different observation.
5. Compare the value with theoretical results.

Observation Table :

Input supply voltage (V)	I1 (mA)	I2 (mA)	Total current (mA) Calculated	Total current (mA) Theoretical

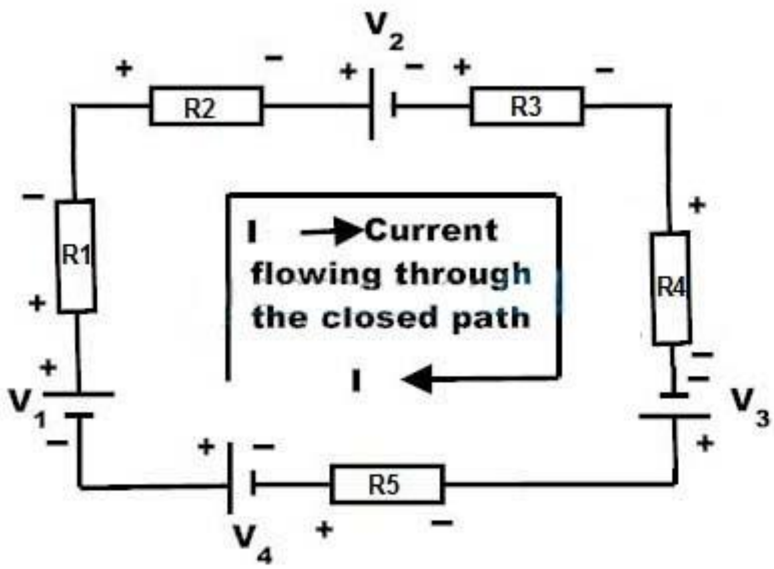
Kirchhoff's Voltage Law (KVL)

Kirchhoff's Voltage Law states that the algebraic sum of voltages in a closed path is equal to zero i.e. the sum of source voltages is equal to the sum of voltage drops in a circuit.

$V1 + (-IR1)$
$V2) + (-$
$V3 + (-IR5)$

$V1 - IR1 -$
$IR3 - IR4 +$
$= 0$

$V1 - V2 +$
$IR1 + IR2$
$IR5$



$+ (-IR2) + (-$
$IR3) + (-IR4) +$
$+ (-V4) = 0$

$IR2 - V2 -$
$V3 - IR5 - V4$

$V3 - V4 =$
$+IR3 + IR4 +$

<u>Procedures :</u>

1. Connect the circuit in the trainer kit as per the circuit diagram.
2. Adjust the input voltage by adjuster for different reading.
3. Connect the voltmeter to get the required voltage.
4. Repeat the same procedure for different observation.
5. Compare the value with theoretical results.

<u>Observation Table :</u>

Loop no.	Supply Voltage (V)	V_{R1} (V)	V_{R2} (V)	V_{R3} (V)	Algebraic sum of voltages
1.					
2.					
3.					

Result :

The Kirchhoff's law (KCL & KVL) is verified with a percentage error of

____

Precautions :

1. Avoid loose connections.
2. Keep all the knobs in minimum position while switch is on and off of the supply.

MAXIMUM POWER TRANSFER THEOREM

Aim:-To Verify the Maximum Power Transfer Theorem

- **APPARATUS** -

  Breadboard, Batteries or DC regulated power supply, Resistors, Digital multimeter, Connecting wires, Alligator clips, Computer and Multisim software for simulation .

- **THEORY** -

  The maximum power transfer theorem states that in a linear, bilateral DC network, maximum power is delivered to the load when the load resistance is equal to the internal resistance of a source.

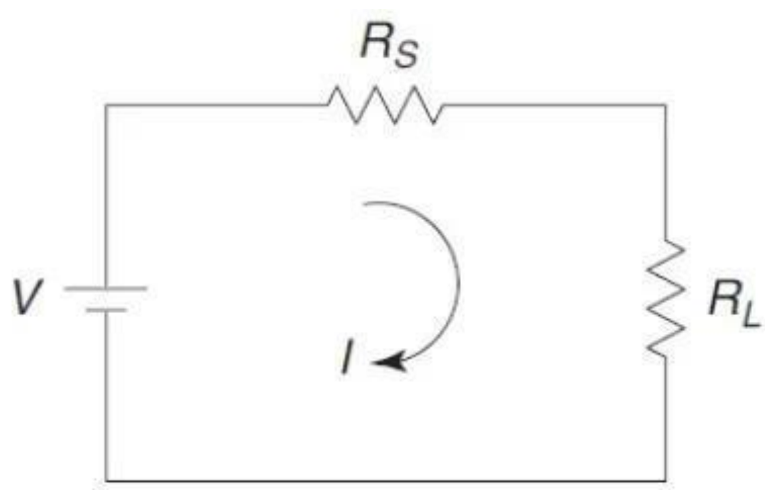


FIGURE 1. Concept of maximum power transfer theorem.

R_s = Source resistance also called Thevenin's resistance. R_L =

Load resistance.

V = Source applied.

I = Current flowing through the circuit.

- **Steps to calculate Pmax by using Maximum power transfer theorem**

1. **Remove the variable load resistor RL.**

2. **Find the open circuit voltage VTH across points A and**

3. **Find the resistance RTH as seen from points A and**

4. **Find the resistance Rlfor maximum power.**

5. **Find the current**

$$I_L = \frac{V_{TH}}{R_{TH}+R_L} = \frac{V_{TH}}{2R_{TH}}$$

6. **Find the maximum power by using formula**

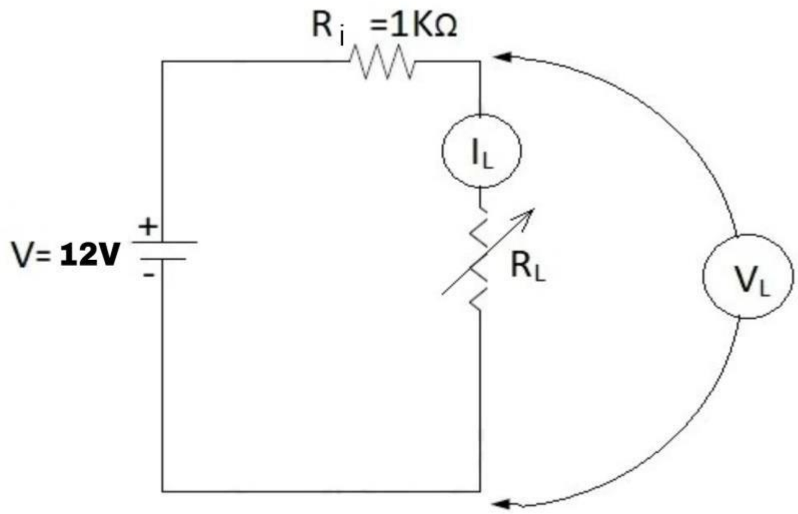
$$P_{max} = I_L^2 R_L$$

$$\therefore P_{max} = \frac{V_{TH}^2}{4R_{TH}^2} R_{TH} = \frac{V_{TH}^2}{4R_{TH}}$$

Or

$$P_{max} = \frac{V_{TH}^2}{4R_L}$$

- **CIRCUIT DIAGRAM**



[You can take any value of source resistance RTH and then can vary load resistor with respect to R_{TH} , accordingly make changes in observation table.]

- **PROCEDURES**
  1. Connect the circuit as shown in the figure 1.
  2. Vary the load resistor RL in steps of 100 Ω and take the readings of voltmeter (V_L) and ammeter (I_L) for different values of R_L.
  3. Take 10 to 15 readings as per observation table.
  4. Calculate power P for each value of R_L.
  5. Plot the graph RL on X-axis versus power P on Y-axis.

- **OBSERVATION TABLE**

S. No.	voltage (volt)	current (mA)	current I(amp)	P = V* I W (watt)	R_L = V/R Ω (Ohm)
1.					
2.					
3.					
4.					
5.					

➢ CALCULATIONS

$R_S = R_{TH} = \Omega$

$V \;\; = V_{TH} = 12\ V$

Theoretically maximum power delivered by the source to load resistance,

➢ PRECAUTIONS

I. Before circuit connection working condition of all the components must be checked.
II. All the connection should be tight.
III. Ammeter must be connected in series while voltmeter must be connected in parallel to the components (resistors).
IV. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.

➢ RESULTS

Calculated maximum power delivered by the source to load resistance

P_{max}=

Practically maximum power delivered by the source to load resistance

P_{max}=

➢ CONCLUSIONS

Power delivered by the source to load resistor is maximum when load resistance is equal to source resistance ($R_L = R_S$). Also, Theoretical and practical value of maximum power is found to be nearly same hence maximum power transfer theorem is verified.