BRAC UNIVERSITY
DEPT. OF COMPUTER SCIENCE AND ENGINEERING
COURSE NO.: CSE250
Circuits and Electronics Laboratory

Experiment No.5

Name Of The Experiment:

Verification of Thevenin's Theorem and Maximum Power Transfer Theorem

PART 1:

OBJECTIVE :

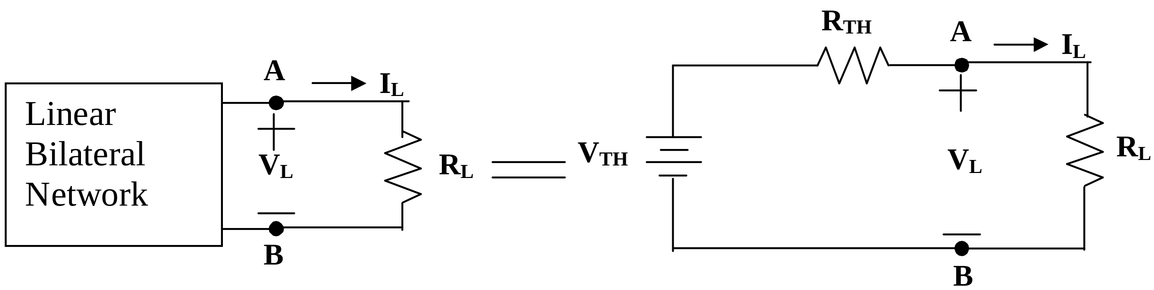
To verify Thevenin's theorem with reference to a given circuit theoretically as well as experimentally.

INTRODUCTION :

It is often desirable in circuit analysis to study the effect of changing a particular branch element while all other branches and all the sources in the circuit remain unchanged. Thevenin's theorem is a technique to this end and it reduces greatly the amount of computations which we have to do each time a change is made. Using Thevenin's theorem the given circuit excepting the particular branch to be studied is reduced to the simplest equivalent circuit possible and then the branch to be changed is connected across the equivalent circuit.

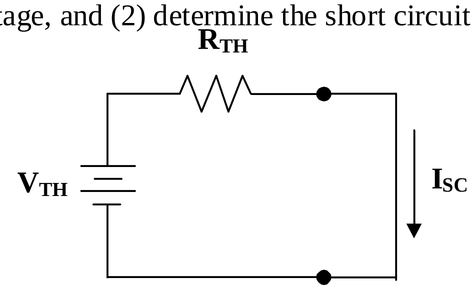
The Thevenin's theorem states that any two terminal linear bilateral network containing sources and passive elements can be replaced by an equivalent circuit consist of a voltage source V_{th} in series a resistor R_{th} where

V_{th} = The open circuit voltage (V_{OC}) at the two terminals A & B.
R_{th} = The resistance looking into the terminals A and B of the network with all sources removed.



There are several methods for determining Thevenin resistance R_{TH}. An attractive method for determining R_{TH} is : (1) determine the open circuit voltage, and (2) determine the short circuit current I_{SC} as shown in the figure; then

$$R_{TH} = \frac{V_{OC}}{I_{SC}}$$



APPARATUS :

- Resistor: R_1:1K, R_2:3.3KΩ, R_3:3.3kΩ
- Multimeter
- DC Power Supply

PROCEDURE :

For Original Circuit:

1. Arrange the original circuit as shown in figure 1.Apply 10V dc from dc power supply.
2. Measure V_L, I_L for three values of R_L & record the data in the table.

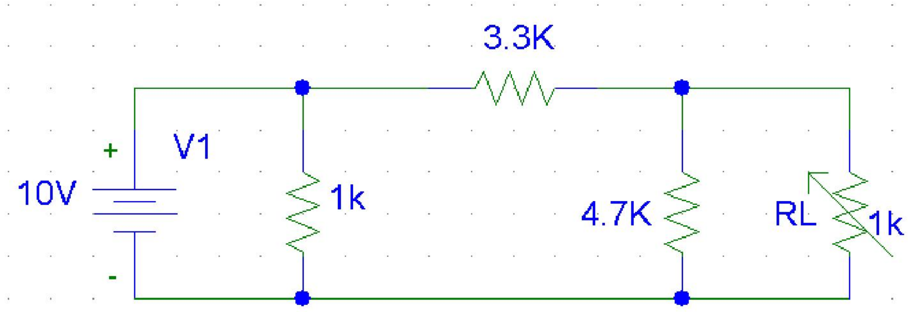


FIG.1: Original Circuit

Table1:

Data for Original circuit R_1= , R_2 = , R_3 = , V_S =

No. of Obs.	Values of R_L	Load Voltage V_L	Load current I_L
1.			

FINDING V_{Th} & R_{TH} :

3. Remove the load resistance R_L and find the open circuit voltage between terminals A & B. This voltage is Thevenin voltage i.e. V_{TH}=V_{OC}.

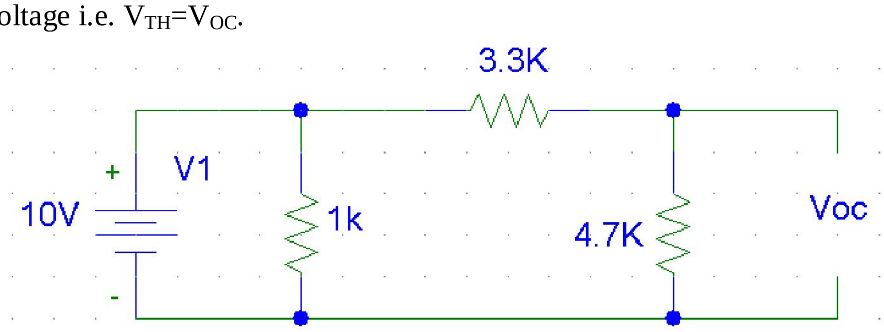


FIG.2: Circuit for finding V_{OC}

4. Place a short circuit between terminals A & B and find the short circuit current I_{SC}. Divide The open circuit voltage by the short circuit current to find the Thevenin resistance R_{TH} i.e $R_{TH} = \frac{V_{OC}}{I_{SC}}$

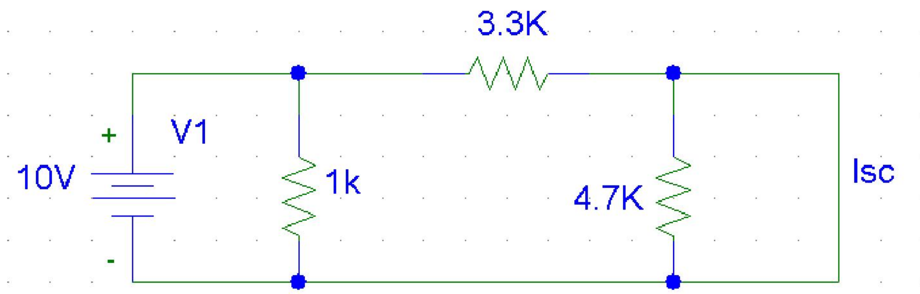


FIG.3: Circuit for finding I_{SC}

<u>For Thevenin Equivalent Circuit:</u>

5. Construct the Thevenin's equivalent circuit as shown in figure 4 setting the power supply at V_{TH} volts and the rheostat at R_{TH} ohms. Now measure the load current I_L and the load voltage V_L for the values of R_L determined in step 2. Compare these values with previous values.

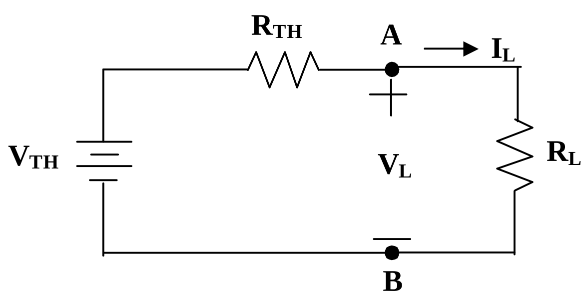


FIG.4: Thevenin Equivalent Circuit of Circuit1.

<u>EXPERIMENTAL DATA:</u>

V_{TH} = , R_{TH} =

Table2: Data for Thevenin equivalent circuit

No. of Obs	Values of R_L	Load Voltage V_L	Load current I_L
1.			

<u>REPORT:</u>

1. Find theoretically the Thevenin equivalent circuit for the values of R_0, R_2, R_3 & V_S recorded in table. Also find I_L, V_L.
2. Show the results in tabular form.
3. Comment on the results obtained and discrepancies (if any).

QUESTION:

1. Define unilateral, bilateral & equivalent circuit.
2. Describe other methods for determining Thevenin resistance.
3. Mention the advantages of using Thevenin Theorem.

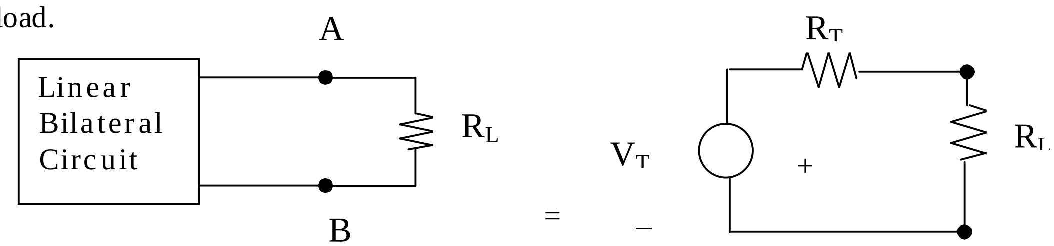
REFERENCE:

- Introduction to Electric Circuits by R.C. Dorf & J.A. Svoboda.
- Introductory Circuit Analysis by R. L. Boylestad.
- A Text Book of Electrical Technology, Vol.1 by B. L. Theraja & A. K. Theraja

PART 2:

OBJECTIVE: The objective of this experiment is to verify maximum power transfer theorem.

THEORY: The maximum power transfer theorem states that a resistive load will receive maximum power when its total resistive value is exactly equal to the Thevenin's resistance of the network as "seen" by the load.



We know that any circuit A terminated with a load R_L can be reduced to its Thevenin's equivalent. Now according to this theorem the load R_L will receive maximum power when R_L=R_{TH}

The efficiency of power transfer is defined as the ratio of the power delivered to the load P_{OUT}, to the power supplied by the source P_{IN}.

$$\%\eta = \frac{P_{OUT}}{P_{IN}} \times 100 = \frac{V_L}{V_{TH}} \times 100 = \frac{R_L}{R_L + R_{TH}} \times 100$$

The voltage regulation is defined as

$$\%VR = \frac{\text{Load voltage at no load} \; - \; \text{Load voltage at full load}}{\text{Load voltage at full load}} \times 100$$

$$= \frac{R_{TH}}{R_L} \times 100$$

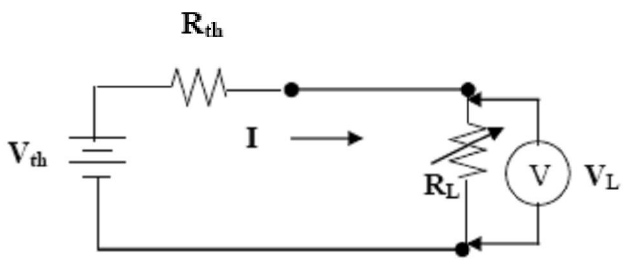
At maximum power transfer condition, η= 50 % & VR= 100 %.
A relatively low efficiency of 50 % can be tolerated in situations where power levels are relatively low such as in electronic & communications circuits for transmission & reception of signal where the Engineer's goal is to receive or transmit maximum amount of power.

However, when large power levels are involved, such as at generating stations, efficiencies of 50 % would not be acceptable. The goal here is high efficiency and not maximum power. Power utility systems are designed to transmit the power to the load with the greatest efficiency by reducing the losses on the power lines. Thus the effort is concentrated on reducing $R_{TH,}$ which would represent the resistance of the source plus the line resistance.

APPARATUS:

1. Multimeter
2. DC power supply
3. Resistors: R_{th}=1.94K (1k+1k), R_L=470, 1K, 1.5K, 1.94K, 3.3K, 4.7K
4. Wires

EXPERIMENTAL SETUP:



PROCEDURE:
1. Set up the circuit as shown in figure.
2. Apply V_{th} from dc power supply.
3. Vary the load resistor from 470Ω to 4.7KΩ & measure the voltages VL & I.

EXPERIMENTAL DATA:

No. of Obs.	V_{TH}	V_L	I	$P_{IN}=V_{TH}I$	$P_{OUT}=V_LI$	LOSS= P_{IN} -P_{OUT}	%η	%VR	$R_L=V_L/I$
1.									
2.									
3.									
4.									
5.									
6.									
7.									

REPORT:

1. Show the results in tabular form.
2. Plot the following curves on the graph paper

i) % η vs R_L
ii) % VR vs R_L
iii) loss vs R_L
iv) P_{OUT} vs R_L
v) I_L vs R_L
vi) V_L vs R_L

QUESTIONS:

1. Why high voltage transmission is used in case of transmitting electric power?
2. Where maximum power transfer is used?
3. Why instead of transmitting maximum power, power utility transmits power at maximum efficiency?
4. Deduce the condition for maximum power transfer.

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- Introduction to Electric Circuits.
  By R.C. Dorf & J.A. Svoboda.
- Introductory Circuit Analysis.
  By R. L. Boylestad