**Electric Circuits (EE-100) Lab Manual Handout # 9**

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| **Marks / Grade** |  |

**EXPERIMENT NO. 9 THEVENIN THEOREM**

# Objectives:

1. Verify the Thevenin theorem through an experiment.
2. Find the Thevenin’s resistance *RTH* by various methods and compare values.

# Equipment:

Resistors DMM

Breadboard

DC power supply Connecting wires.

# Prerequisite:

Before coming to the lab, students must study and practice the Thevenin theorem, and also review other circuit analysis techniques.

# Theory Overview:

Thevenin theorem states that any linear two-terminal circuit (Fig. 9.1a) can be replaced by an equivalent circuit (Fig. 9.1b) consisting of a voltage source *VTH* in series with a resistance *RTH* where

* *VTH* is the open-circuit voltage at the terminals, and
* *RTH* is the equivalent resistance seen through the terminals provided that all the independent sources are turned off.

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Linear two- terminal circuit

Load

Load

**Figure 9.1a: A linear two-terminal circuit Figure 9.1b: Thevenin equivalent circuit**



**Finding *VTH*:** Determine the output voltage *Vab* in open-circuit condition (no load resistor meaning infinite resistance). This is known as the Thevenin voltage *VTH*.

i.e. *VTH* = *Vab* = *VOC* (open-circuit voltage)

## Voltmeter



+

V

-

a

Circuit

b

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**Finding *RTH*:** There are different methods to find value of *RTH* as described below.

1. **Method A:** (By measuring *ISC* – short-circuit current)

Short the points ‘a’ and ‘b’, then measure the short-circuit current *ISC* using an ammeter. Calculate *RTH* as follows,

*RTH = VTH / ISC* (9.1)

*ISC*

## Ammeter

A

b

Circuit

a

1. **Method B:** (By measuring the equivalent resistance)

Remove all sources from the circuit, i.e. replace all voltage sources with a short- circuit and current sources with an open-circuit. Then with the help of a multimeter find the resistance between the points ‘a’ and ‘b’, denoted by *Req*.

*RTH = Req* (9.2)

## Multimeter

Req

Ω

b

Turn-off all

the sources

a

1. **Method C:** (By applying known voltage and measuring source current)

We can also find *RTH* by applying a known voltage to the circuit between points ‘a’ and ‘b’, then measuring the current from the voltage source. Suppose Vtest = 1 V is applied as the test voltage then,

*RTH = Vtest / I* (9.3)



Ammeter

I

a

Turn-off all

the sources

Req

b

A

+-

Vtest

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1. **Method D:** (By inserting two different resistors and measuring current)

There is another method to find the value of *RTH*, by inserting two different loads between points ‘a’ and ‘b’ i.e. insert resistors *R11* and then *R22* one by one and write expression for the current through that particular resistor as given below,

Current through the resistor *R11* :- I1

R11

b

Circuit

a

*I1* = *VTH* / (*RTH* + *R11*) (9.4)

Current through the resistor *R22* :- I2

R22

b

Circuit

a

*I2* = *VTH* / (*RTH* + *R22*) (9.5)

Simultaneously solving equations (9.4)-(9.5) will give the value of *RTH*.

# Procedure:

* + Connect on breadboard the circuit shown in Fig. 9.2.
  + The aim is to determine the current through the 1kΩ resistance *R1* connected between the two nodes A and B.
  + The voltage across the 1kΩ resistance *R1* connected between the two nodes A and B.

**Safety Precautions**

* Look at each exercise carefully before connecting the circuits.
* Make sure all power is off before connecting or disconnecting components.
* Ask your TA to check the circuit before turning on the power.
* When measuring voltage or current, make sure the DMM is correctly set for what you need to measure.

Follow the following procedure to validate the Thevenin’s theorem.

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**Finding *VTH*:**

1. Remove the resistor *R1* from the circuit on breadboard.
2. Determine the open-circuit voltage (voltage between points A and B i.e. *VAB*) using a voltmeter. This is the required Thevenin voltage *VTH*. Record the value in Table 9.1.

**A** R5 **B** R4



R1

V1

**C**

R2

**D**

10Vdc

R3

**E**

V2

5Vdc

0

**Figure 9.2: Example circuit to test the validity of the Thevenin’s theorem**

**A B** R4



R1

V1

**C**

R2

**D**

10Vdc

R3

**E**

V2

5Vdc

0

**Figure 9.3: Finding *VTH***































