EXPERIMENT 5

Thevenin's Equivalent

5-1 Objective:

To verify the Thevenin's Theorem.

5-2 Introduction:

Thevenin's theorem is the means of simplifying a rather complicated linear network into an equivalent circuit where there are two terminals of interest which are normally across a certain load. The load could assume any form or structure such as purely resistive, capacitive, inductive or a combination of all of that or simply a whole new circuit stage.

In order to measure the Thevenin's voltage & Thevenin's resistance, the load is removed from the terminals:

a- To measure the Thevenin's voltage simply use a multimeter set to measure voltage and measure the voltage across the terminals where the load got disconnected.

b- To measure the Thevenin's resistance, remove the source from the circuit and replace it by a wire if it is a voltage source and leave it open if it is a current source.

5-3: Discussion

- Often when an external circuit component is connected to two points on a circuit (ex: a system), it is imperative to realize what voltage and what resistance are seen between those two points.
- In fact, there is a voltage and a resistance seen between any two points in the circuit.
- The resistance and voltage seen between those two circuit points are called the Thevenin's equivalent between those two points.
- There is also the current equivalent of the thevenin's equivalent which is called the Norton Equivalent.
- The Norton equivalent is made of I-Norton (IN)and R-Norton (RN). Where IN is represented by a current source that is in parallel with RN and:
    - IN = Vth / Rth &
    - RN = Rth

A Block diagram representation of a thevenin's equivalent is as shown in **Figure-A**

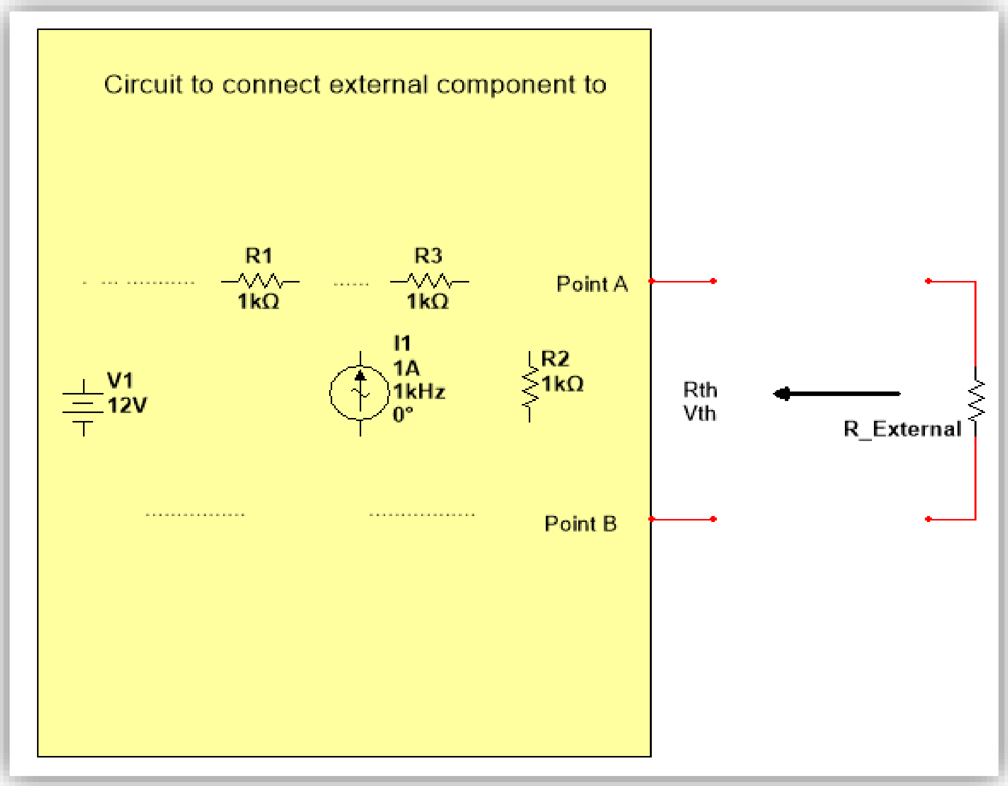

Figure-A

The thevenin's equivalent circuit is shown in **Figure-B**

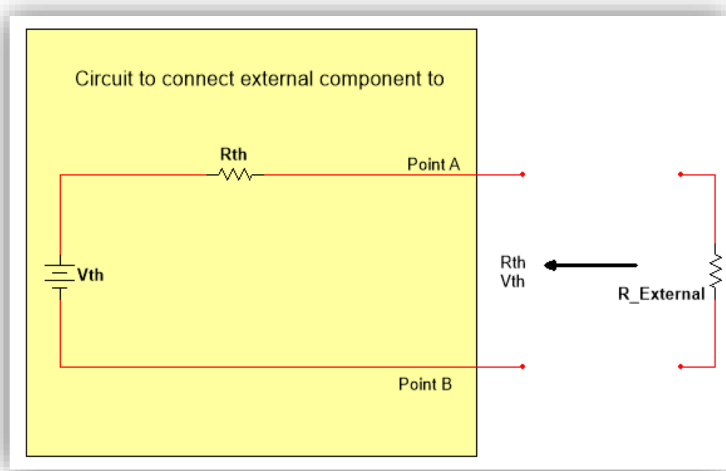

Figure-B

- The Norton’s equivalent circuit is shown in **Figure-C**

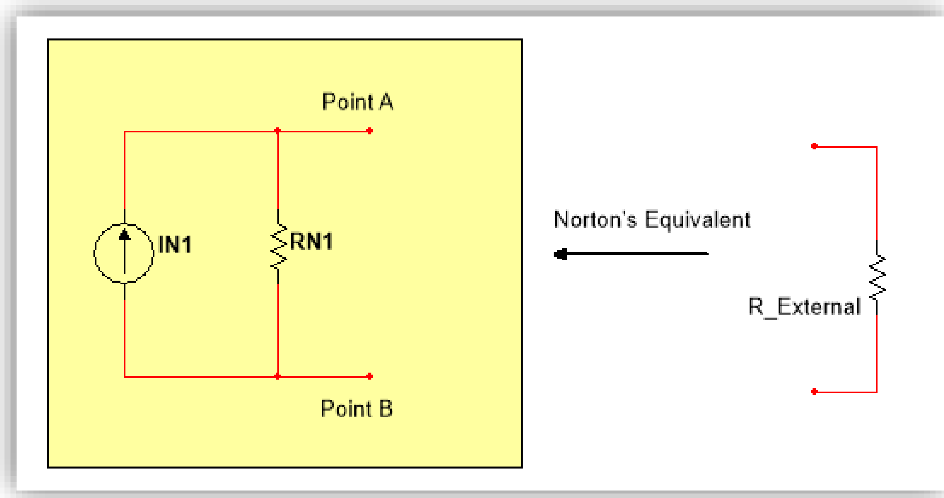

Figure-C

- R_External is the component that is to connect to two circuit point A & B.
- Between Points A & B, there are always:
    - Vth, which is the voltage seen between points A & B. Think of it as the voltage reading you get when you connect a voltmeter across points A & B.
    - Rth, which is the resistance seen between points A & B. Think of it as the resistance reading you get when you connect an ohmmeter across points A & B with all the power sources replaced by their internal resistances.
        - The internal resistance of a voltage source is ideally 0, therefore the voltage source is replaced by a short circuit.
        - The internal resistance of a current source is ideally infinity. Therefore, the current source is replaced by an open circuit.

Why Thevenin’s:

- Some of the reasons why the thevenin’s equivalent is needed are:
    - The current that flows into the load connected to the circuit whose thevenin’s equivalent is determined would be known and based on that, the correct load with the correct power ratings can be determined.
    - Maximum power is transferred to the load if the value of the load is equal to the thevenin's resistance Rth. Examples of that are:

- LAN segments ae normally terminated by a 220 Ω resistance. This is because the thevenin's resistance of the LAN segment has a value of 220 Ω. Therefore, maximum power transfer occurs.
- TV antenna wires are connected to the TVs through two connectors on the back of the TV. One connector indicates 60 Ω and the other 75 Ω.
    - The 60 Ω is used for the VHF band (very high frequency). With those frequencies, the thevenin's resistance of the antenna wires is equal to 60 Ω.
    - The 75 Ω is used for the UHF band (Ultra very high frequency). With those frequencies, the thevenin's resistance of the antenna wires is equal to 75 Ω

5-4 Procedure:

Step 1:

Measure and record the resistance of 5 resistors listed in **Table 5-1**

Component	Listed Value	Measured Value
R1	1K	
R2	1.2K	
R3	2.2K	
RL1	3.3K	
RL2	4.3K	

Table 5-1

<u>Step 2</u>:

For the circuit shown in **Figure 5-1**. Points X &Y represent the output terminals.

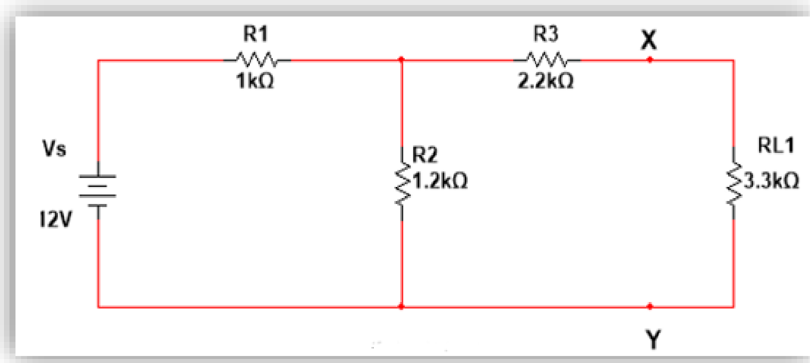

Figure 5-1

Using Nodal Analysis to calculate the voltage across RL1 by using Node A & Node B as shown in **Figure 5-2. VB** will be the voltage across RL1 which is labeled as **VL1** in **Table 5-2.**

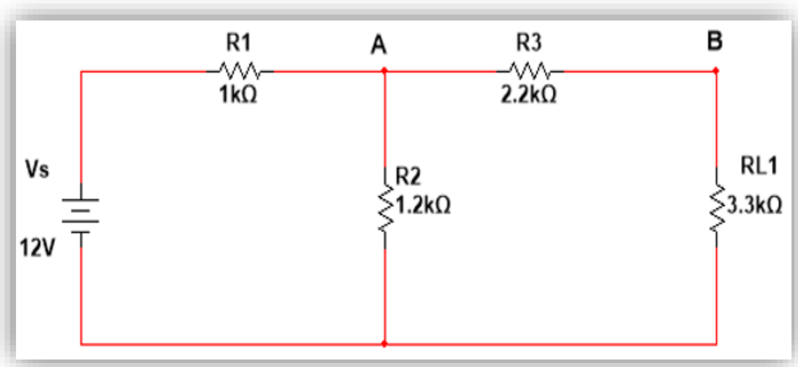

Figure 5-2

<u>Show the Nodal Equations and solution for VB in the following provide space and place your answer in Table 4-2 as the computed value</u>

<u>Construct the circuit of Figure 5-2 and measure the voltage across RL1 and place the measurement result as the measured value in Table 5-2</u>

	Computed	**Measured**
VL1		

Table 4-2. Computed Load voltage using Nodal Analysis and Measured Load Voltage

<u>Step 3:</u>

Find the Thevenin's Equivalent seen by the load resistance RL1. Show your work.

Your final circuit should look like that in **Figure 5-3**.

Place the calculated VTH and RTH in **Table 5-3**.

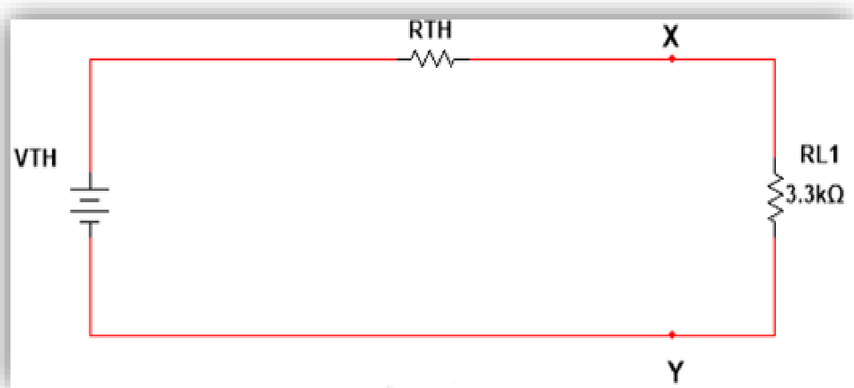

Figure 5-3

Using Figure 5-3 with the calculated values of VTH & RTH, calculate the voltage across RL1, **VL1** and place the calculated value in **Table 5-3**

	Calculated	Measured
VTH		
RTH		
VL1		

Table 5-3

<u>Step 4:</u>

Construct the circuit shown in **Figure 5-3** using the calculated values for VTH and RTH obtained in Step3. Measure the voltage across RL1 and enter the measured value under VL1.

<u>Step 5:</u>

Repeat steps 2 through 4 but use RL2 instead of RL1

5-5 <u>Conclusion:</u>

The measured value for VL1 in Table 5-3 should match that entered in Table 5-2.

This concludes this experiment.