ECE 281

Electrical Circuits and Instrumentation + Laboratory

Fall 2016/2017

LAB # 8

28.11.2016

Thevenin and Norton Equivalent circuits: Thevenin and Norton Equivalent Circuits are simplified circuit diagrams of a more complex circuit. When some basic operations are performed (like open circuit and short circuit), the complex circuit turns into simplified one with same characteristics between the selected terminal nodes. The complex circuit and the simplified circuit are equivalent to each other.

Objective:

1. **To find V_{th} and R_{th} between two points in a circuit by measurement.**
2. **To find I_N and R_N between two points in a circuit by measurement.**
3. **Maximum power transfer**

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1. To find V_{th} and R_{th} between two points in a circuit by measurement (30 Points)

For a Thevenin Equivalent circuit we can refer to Figure 1 where R_{TH} is the Thevenin equivalent resistance between points A and B and V_{TH} is the Thevenin equivalent voltage between points A and B (open circuit voltage between points A and B).

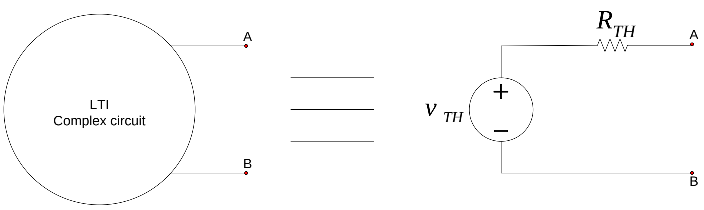

Figure 1: Thevenin Equivalent Circuit.

Procedure:

1. Construct the circuit in Figure 2 **(R_1= 1kΩ, R_2= 5kΩ, R_3= 5kΩ, V_S= 10 Volt)**.

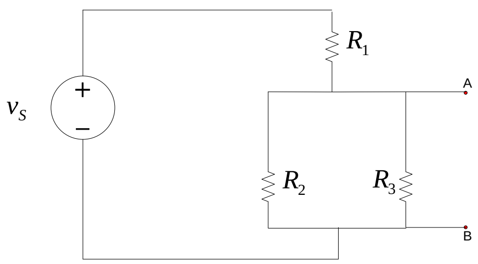

Figure 2

2. Firstly, in order to find V_{TH} connect a Voltmeter between points A and B as in Figure 3. The voltmeter will measure the **open circuit voltage between points A and B (V_{TH}).**

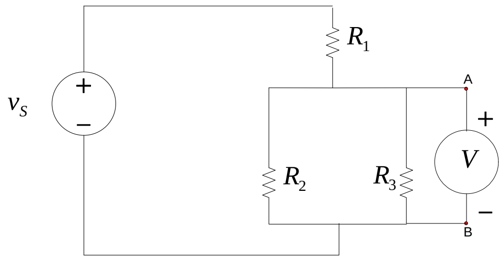

Figure 3

3. Now, put a potentiometer (nominal value 10 kΩ) between points A and B as in Figure 4 and adjust the potentiometer such that potential difference between the nodes A and B is equal to $\frac{V_{TH}}{2}$. After this point, disconnect the potentiometer from the circuit and find potentiometers' adjusted resistance value which will give us R_{TH}.

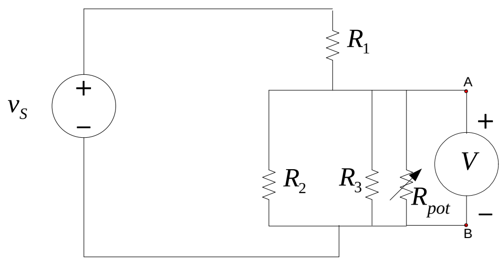

Figure 4

4. Now compare your theoretical results (by deriving the Thevenin Equivalent Circuit theoretically) with the experimental results. Write your results on Table 1.

	Theoretical Results	Experimental Results
V_{TH}		
R_{TH}		

Table 1: Table for comparing the theoretical and experimental results

2. To find I_N and R_N between two points in a circuit by measurement (20 Points)

Similar to Thevenin equivalent circuit, we can use Figure 5 for Norton equivalent circuit. In Figure 5, **R_N is the Norton equivalent resistance between points A and B and I_N is the Norton equivalent current between points A and B (short circuit current from A to B)**. R_N and R_{TH} are equal to each other and $R_{TH} = R_N = \frac{V_{TH}}{I_N}$ always hold.

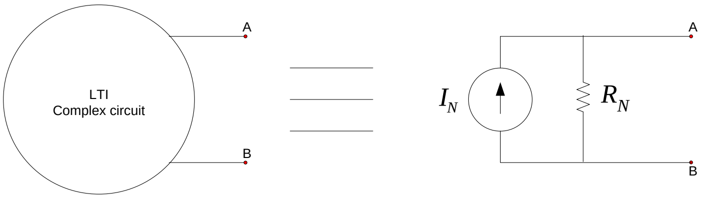

Figure 5: Norton Equivalent Circuit

Procedure:

1. Again use the circuit shown in Figure 2.
2. This time instead of the voltmeter connect an ampere meter as in Figure 6. The ampere meter will measure the **short circuit current from node A to node B (I_N)**.

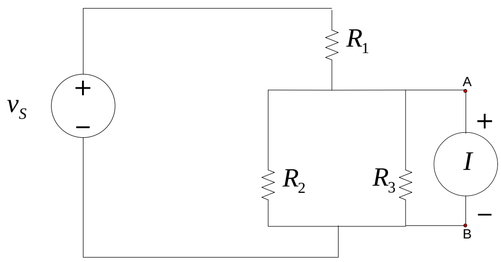

Figure 6

3. Now compare your theoretical results (by deriving the Norton Equivalent Circuit theoretically) with the experimental results. Write your results on Table 2.

	Theoretical Results	Experimental Results
I_N		
R_N		

Table 2: Table for comparing the theoretical and experimental results

Questions:

- Draw equivalent Thevenin and Norton circuits.
- Why the value shown by the potentiometer equal to R_{th} when the voltage is equal to $\frac{V_{TH}}{2}$?

3. Maximum Power Transfer (50 Points)

Procedure:

1. Construct the circuit shown in Figure 7 **(V_S=10 Volt, R_1=5 kΩ, R_{pot}=10 kΩ (nominal value)**.

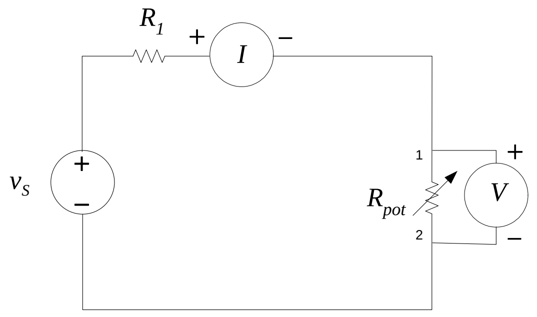

Figure 7: Circuit for current and voltage measurement over a potentiometer.

2. Use **digital multimeter as ampermeter** your measurements.
3. In the set up, the potentiometer will be externally adjusted to 0, 1000, 2000,…., 10000 Ω values respectively in order as shown in Table 3 (disconnect the potentiometer from the circuit, adjust it to the required value than connect the potentiometer to the circuit once again for voltage and current measurements at each step).
4. According to these adjusted resistance values, you are supposed to measure the voltage and current values and calculate the power values associated with each measurement for the potentiometer.
5. Finally Draw P_{pot} (power produced over the potentiometer) as a function of R_{pot} (resistance of the potentiometer) over Figure 8 using the data you have obtained from Table 3.

	R_{pot} (Ω)	I (measured) (mA)	V (measured) (Volt)	P_{pot} (Watt)
1.	0			
2.	1000			
3.	2000			
4.	3000			
5.	4000			
6.	5000			
7.	6000			
8.	7000			
9.	8000			
10.	9000			
11	10000			

Table 3: Voltage and current measurements and power calculation over R_{pot}

Figure 8: Plot of power versus the resistance over the potentiometer

Questions:

- When (at which resistance values) does maximum power is delivered to the potentiometer? Why?