ECE 233
Laboratory Experiment 6
Thevenin and Norton Equivalent Circuits and Maximum Power Transfer

Thevenin and Norton Equivalent circuits: Thevenin and Norton Equivalent Circuits are simplified circuit diagrams of a more complex circuit. When the 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.

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)**. Similarly we can use Figure 2 for Norton equivalent circuit. In Figure 2, **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.

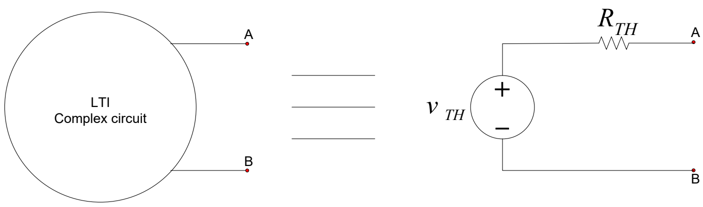

Figure 1: Thevenin Equivalent Circuit.

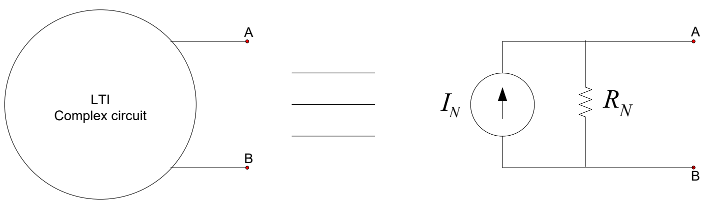

Figure 1: Norton Equivalent Circuit

1-) Construct the circuit in Figure 3 **(R_1= 1kΩ, R_2= 5kΩ, R_3= 5kΩ, V_S= 10 Volt)**.

a) Firstly, in order to find V_{TH} connect a Voltmeter between points A and B as in Figure 4. The voltmeter will measure the **open circuit voltage between points A and B (V_{TH}).**

b) This time instead of the voltmeter connect an ampermeter as in Figure 5. The ampermeter will measure the **short circuit current from node A to node B (I_N)**.

c) Finally, put a potentiometer (nominal value 10 kΩ) between points A and B as in Figure 6 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}.

d) Now compare your theoretical results (by deriving the Thevenin Equivalent Circuit theoretically) with the experimental results (obtained through part a, b, c, and d). Write your results on Table 1.

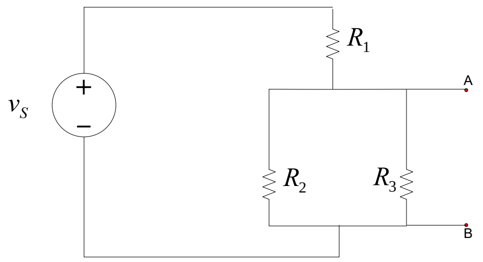

Figure 3:

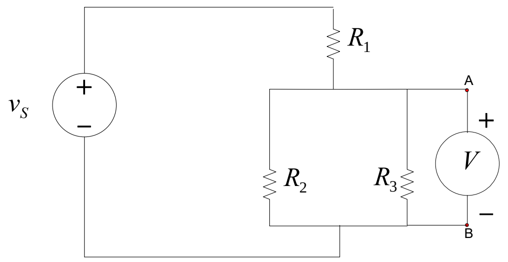

Figure 4:

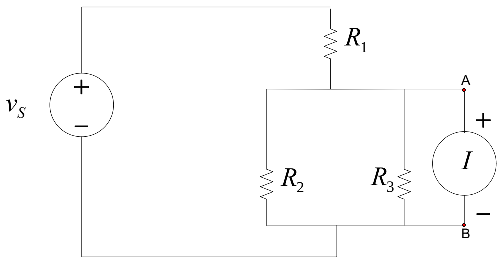

Figure 5:

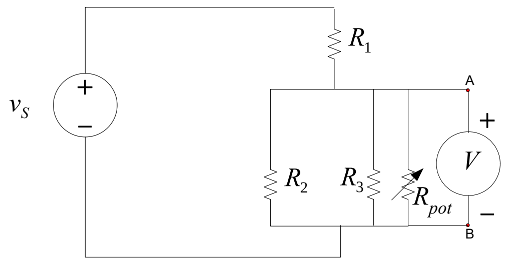

Figure 6:

Table 1: Table for comparing the theoretical and experimental results

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

Questions:

- At part 'd' of the first experimental procedure, a set up is prepared to obtain the Thevenin Equivalent resistance value R_{TH}. How do we know that this set up will work and give the required R_{TH} value. Give a theoretical proof, for the justification of this set up.

2-) Construct the circuit shown in Figure 7 **(V_S=10 Volt, R_1=5 kΩ, R_{pot}=10 kΩ (nominal value)**. Use **digital multimeter as ampermeter** and **analog multimeter as voltmeter** in you're your measurements. In the set up, the potentiometer will be externally adjusted to 0, 1000, 2000,.., 10000 Ω values respectively in order as shown in Table 2 (disconnect the potentiometer form 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). 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. 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 in Table 2.

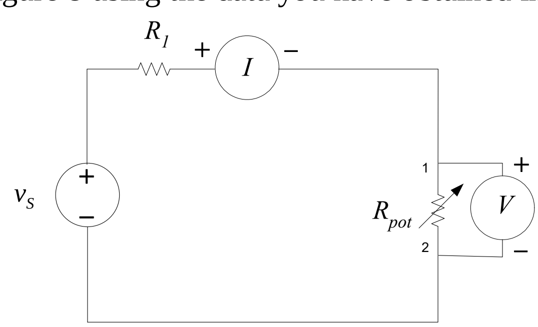

Figure 7: Circuit for current and voltage measurement over a potentiometer.

Table 2: Voltage and current measurements and power calculation over R_{pot}

	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			

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?