Faculty of Engineering and Technology

Electrical and Computer Engineering Department

ENEE2103

Circuits and Electronics Lab

Experiment No.2 - Pre Lab No.1

Circuit Laws and Theorems

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Section: 5.

March 18, 2022

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1. KVL and KCL

- **The circuit simulation using PSpice software:**

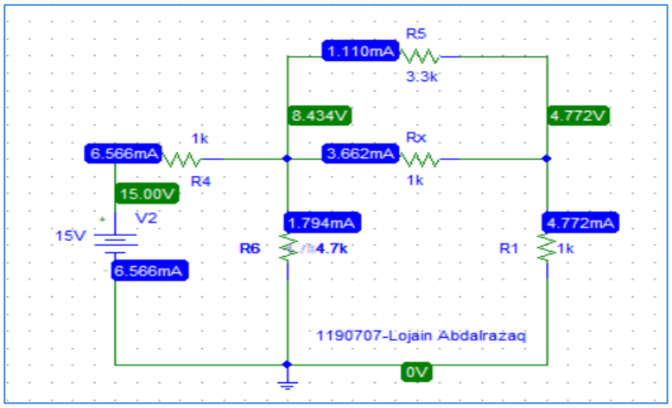


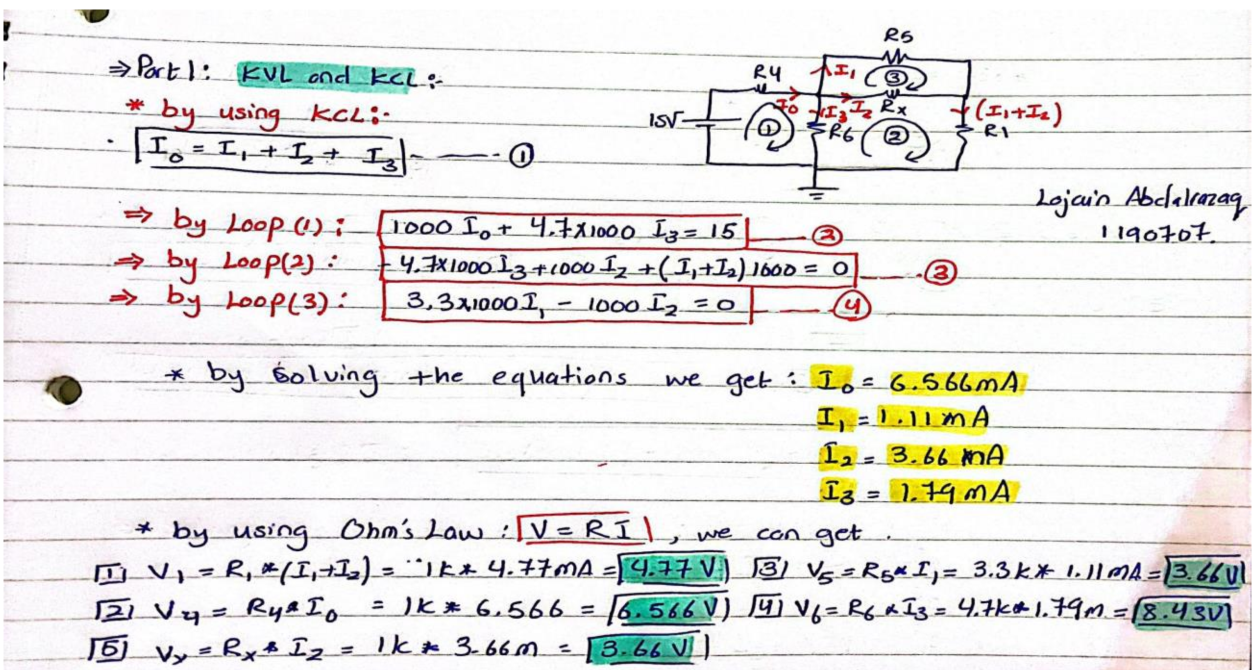
Fig1.1: Circuit simulation using PSpice.

- **Filling the values of voltages and currents in the table:**

Table (1.1)

Vs	Pot	R1		R4		R5		R6		Rx	
		V1	I1	V4	I4	V5	I5	V6	I6	Vx	Ix
15 V	Rx	4.77	4.77m	6.56	6.56m	3.66	1.11m	8.43	1.79m	3.66	3.66m

- **Verifying the results theoretically:**


⇒ Part 1: KVL and KCL :-

* by using KCL :-

$\boxed{I_0 = I_1 + I_2 + I_3}$ ---- (1)

R5, R4, I_1, (3), 15V, I_0, I_3, I_2, Rx, R6, (1), (2), (I_1+I_2), R1

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⇒ by Loop (1) : $\boxed{1000\, I_0 + 4.7 \times 1000\, I_3 = 15}$ ---- (2)

⇒ by Loop (2) : $\boxed{-4.7 \times 1000\, I_3 + 1000\, I_2 + (I_1 + I_2)\, 1000 = 0}$ ---- (3)

⇒ by Loop (3) : $\boxed{3.3 \times 1000\, I_1 - 1000\, I_2 = 0}$ ---- (4)

* by solving the equations we get : $I_0 = 6.566mA$

$I_1 = 1.11mA$

$I_2 = 3.66mA$

$I_3 = 1.79mA$

* by using Ohm's Law : $\boxed{V = RI}$, we can get .

[1] $V_1 = R_1 * (I_1 + I_2) = 1k * 4.77mA = \boxed{4.77V}$ [3] $V_5 = R_5 * I_1 = 3.3k * 1.11mA = \boxed{3.66V}$

[2] $V_4 = R_4 * I_0 = 1k * 6.566 = \boxed{6.566V}$ [4] $V_6 = R_6 * I_3 = 4.7k * 1.79m = \boxed{8.43V}$

[5] $V_x = R_x * I_2 = 1k * 3.66m = \boxed{3.66V}$

Fig1.2: Circuit solution theoretically.

2. Voltage and Current Division

- **The circuit simulation using PSpice software:**

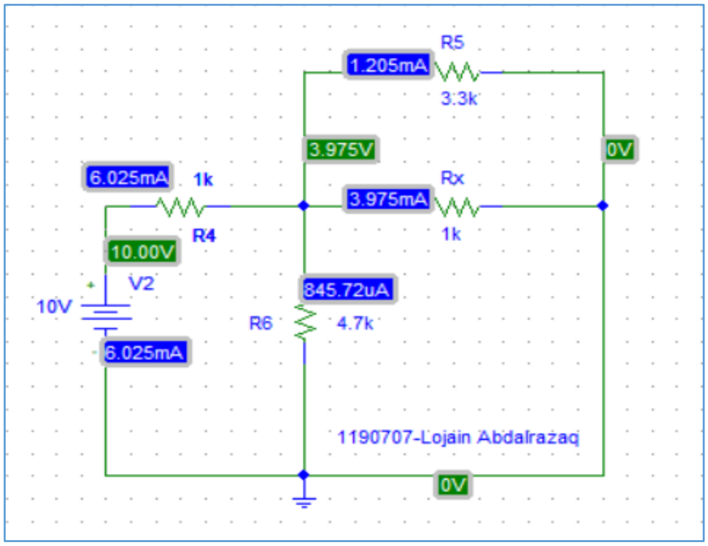

Fig1.3: Circuit simulation using PSpice.

- **Filling the values of voltages and currents in the table:**

Table (1.2)

Vs (volt)	Pot.	I4	I5	I6	Ix
10	Rx	6.025mA	1.205mA	845.72uA	3.975mA

- **Verifying the current divider rule theoretically:**

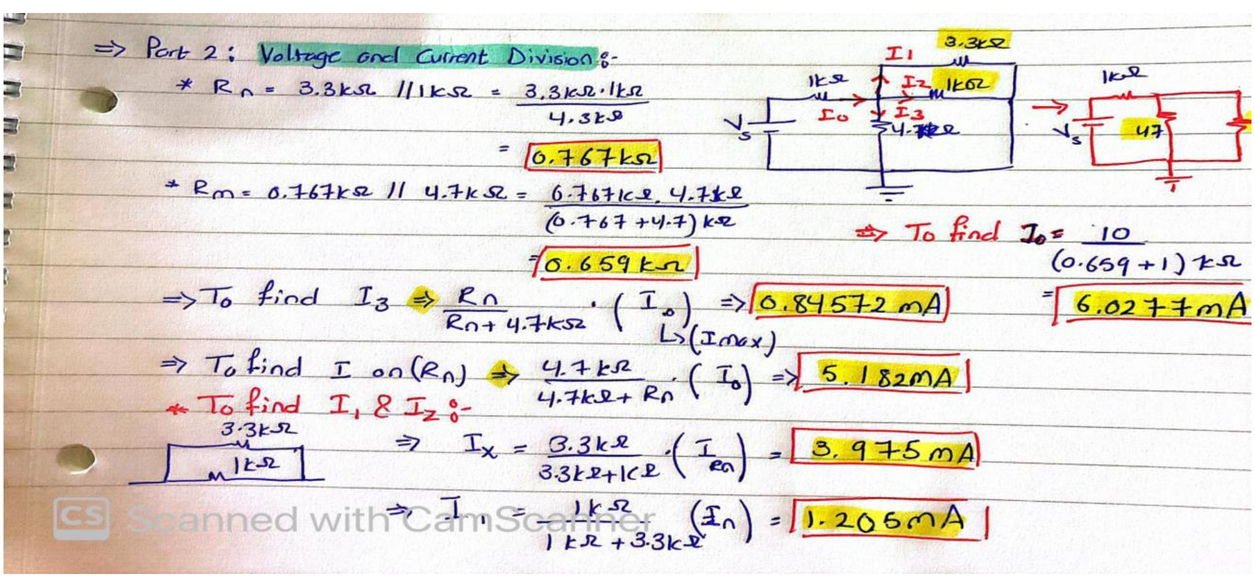

Fig1.4: The results of Current Divider Rule theoretically.

3. Superposition

- **<u>Case 1: When Vs1=5V and Vs2=10V:</u>**

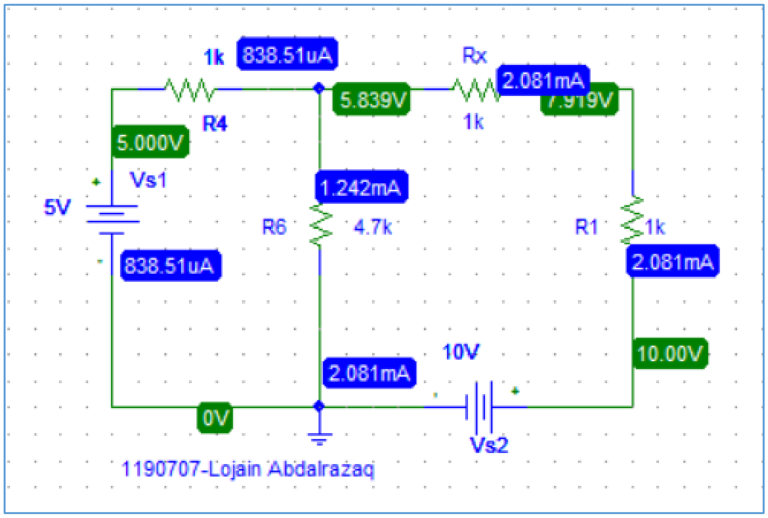

Fig1.5: Case 1 circuit simulation using PSpice.

Using the results of the simulation, the current at R6 is **1.242mA** and the voltage equals to **5.837V** (using Ohm's Law: V=RI).

- **<u>Case 2: When Vs1 = 0V and Vs2=10V:</u>**

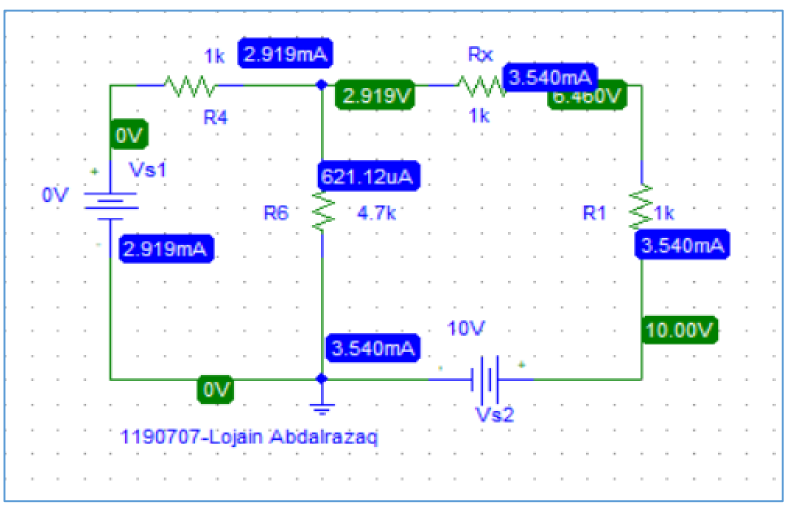

Fig1.6: Case 2 circuit simulation using PSpice.

Using the results of the simulation, the current at R6 is **621.12uA** and the voltage equals to **2.919V** (using Ohm's Law: V=RI).

- **Case 3: When Vs1 = 5V and Vs2=0V:**

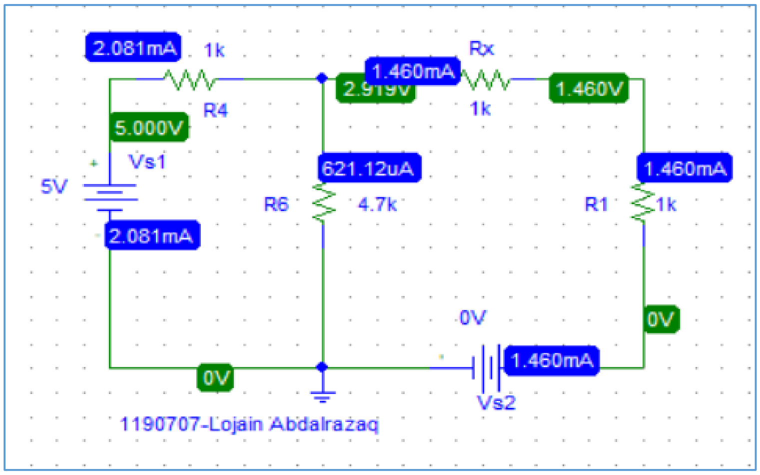

Fig1.7: Case 3 circuit simulation using PSpice.

Using the results of the simulation, the current at R6 is **621.12uA** and the voltage equals to **2.919V** (using Ohm's Law: V=RI).

The summery of the results in the three cases:

Table (1.3)

Vs1(volt)	Vs2 (volt)	V6 (volt)	I6 (mA)
5	**10**	5.837V	1.242mA
0	**10**	2.919V	621.12uA
5	**0**	2.919V	621.12uA

- **The relation between the values of the current is that the first case (when Vs1=5V and Vs2=10V) is the result of adding the current values in case 2 and case 3. In another word, the value of I6 in the first case I6=621.12u+21.12u=1.242mA.**
- **The relation between the values of the voltages is that in the first case, the value of the voltage (5.837V) is equal to the result of adding the voltages in case 2 and case 3. In another word, the voltage V6 in the first case V6=2.919+2.919=5.837V.**

4. Thevinin and Norton equivalent circuits

- **<u>Connecting the circuit with Vs1=5V and Vs2=10V:</u>**

From the circuit shown in Fig1.8, we find that the voltage across R1 is **2.08V** (**10-7.919=2.08V**).

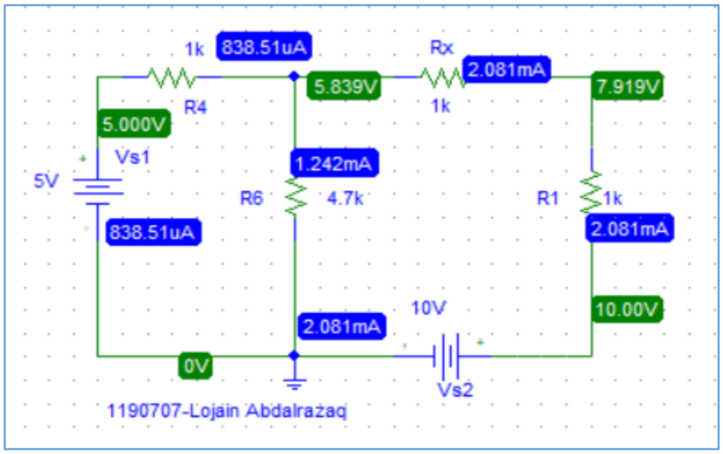

Fig1.8: circuit simulation using PSpice.

- **<u>Finding Voc(open circuit voltage) by using very high R(Rload=100meg):</u>**

To find the value of the open circuit voltage(Voc)=10-4.123=**5.877V**.

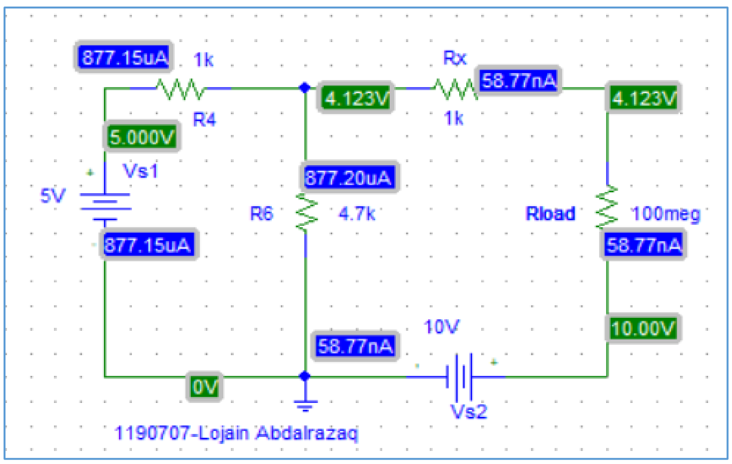

Fig1.8: Finding Voc using Rload=100meg.

- **<u>Measuring the current in the short circuit (Isc):</u>**

From the figure shown we find that **Isc=3.221mA.**

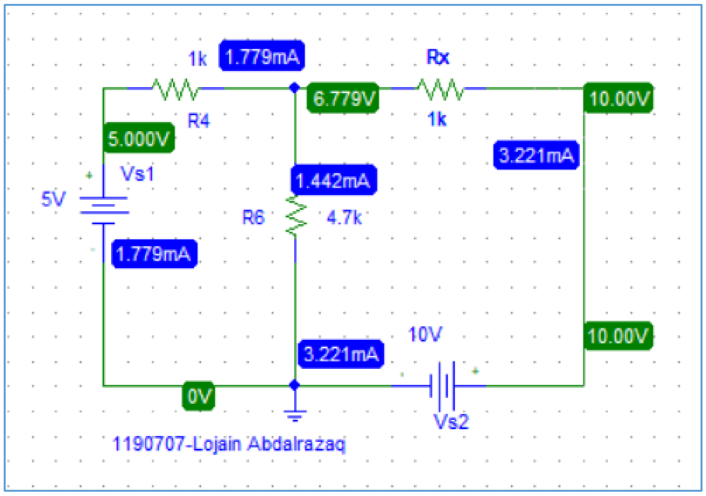

Fig1.9: Finding Isc.

- **<u>Measuring the resistance (Rab=Rth):</u>**

Replacing all voltage sources with short circuit to find Rth.
Rab = Rth = (R4 // R6) + Rx = 1.824 k.

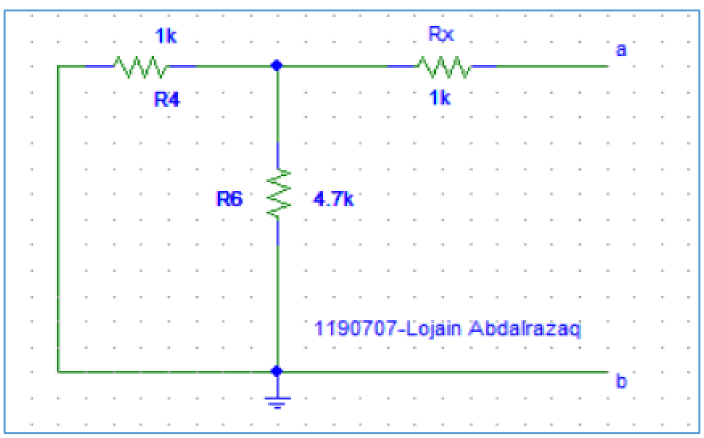

Fig1.10: Finding Rth.

- **<u>Finding R1,Vo using Thevenin and Norton equivalent circuit:</u>**

Now, it known that Vth = Rth* Isc = 1.824k * 3.221mA = **5.8769V**, and as shown the value of V across R1 is **2.081V**.

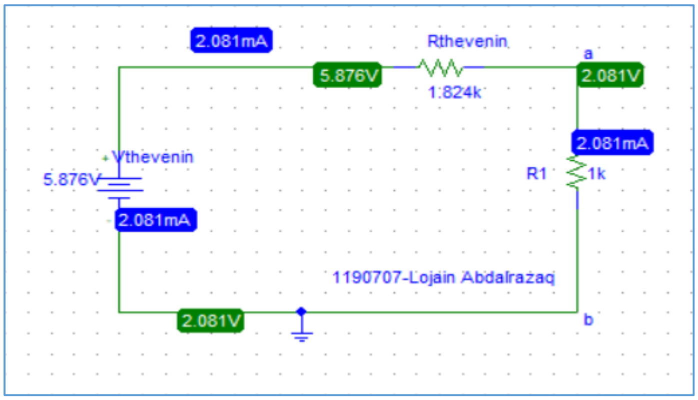

Fig1.11: Thevenin and Norton Circuit simulation using PSpice.

- ✓ **Also, Comparing the voltage across R1 to its value measured in the step of Vs1=5V and Vs2=10V, and using Thevenin and Norton circuit, we find that the value of the both voltages is <u>equal (V=2.18V).</u>**