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EGR 24L Introduction of Circuit Analysis Laboratory

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Lab 1: Introduction to Tinkercad and LTspice, Voltage and Current Divisions

Introduction:

This is the first lab; we explored the basic idea of circuits, resistors, transistors and how to put all components together on breadboard, make it into circuit. We also learned the basic how to operate two computer application tools which are Tinkercad and LTspice. These two tools are fundamental and significant important for engineer Its help stimulating a realistic circuit design with the output of voltage, current, and resistor data, etc. After discussion in the class, we learn how to create four simple circuits on LTspice. Additionally, we also gain an understanding of DMM on LTspice by learning how to make a visual DMM (Digital Multi Meter) to determine the voltage value from series and parallel resistor circuits as well. Furthermore, in this first lab had also introduced us to gain some useful insights into voltage and current division rule (VDR and CDR).

Procedure:

1. In the first part of the experiment, we used LTspice to stimulate the drawing from the spec sheet, the first circuit designed was displaying resistor connecting in series on the Circuit, we use the Voltage division rule (VDR) to determine the value of (VR1): V(R2) in Voltage. Then, we had to verifying the value whether it matches the value from the spec sheet. The value was verified correctly from the software to theoretical value.

2. Second part of the experiment, we continuing to use LTspice to stimulate the drawing from the spec sheet, the second circuit designed was displaying 3 resistor connecting in on the Circuit, we use the Voltage division rule (VDR) to determine the value of (VR1): V(R2) : V(R3) in Voltage. Then, we had to verify the value whether it matches the value from the spec sheet. The value as verified correctly from the software to theoretical values.

3. Third part of the experiment, we continuing to use LTspice to stimulate the drawing from the spec sheet, the third circuit is designed with resistors connected in parallel on the circuit. To determine the voltage across the circuit we had to use current division rule (CDR). After we obtain the value, we had to verify the value from the program to the spec sheet. We use visual DMM on LTspice that we learned in the class applied to this part of the experiment to ensure that the value from experiment is correct. Certainly, we see the value was verified correctly from the software to theoretical value.

4. Lastly, at this end of the experiment, we are now drawing more advance circuit. We designed the circuit with three resistors connect parallel to each other on the circuit. To determine the voltage across the circuit we must use Current Divider Rule for resistive circuit (CDR) in this part and verify the value from the LTspice to theoretical value.

Conclusion: In the first lab, I did learn about the fundamental of circuit components and understanding how to construct a circuit using software LTspice and Tinkercad. Construct the circuit is basic knowledge that every engineer should know. It is very essential core of semi-conductor technology. Furthermore, In the class professor went through introduced the circuit components such as transistor, resistors, and breadboard. He also mentioned that later in the class we will be able to do it as a real circuit. He also shows us how the circuit connect in parallel and in series. Which make me understand more how the different of resistors connected on the circuit. After I did the first experiment, I did understand more how to build circuit and how to use LTspice to stimulate the calculation and create schematic of the real circuit. Overall, the first lab taught me so much, I know more about circuit and be able to draw the schematic circuit design on stimulator LTspice efficiently.

Appendixes:

According to the Ohm's Law

The basic knowledge of Ohm's law that we learn to determine voltage, resistance and current.

$$V = IR\ , I = \frac{V}{R}\ \ and\ R = \frac{V}{I}$$

The Voltage Divider Rule (VDR) state that the voltage across an element or across a series combination of elements in a series circuit is equal to the resistance of the element or series combination of elements divided by the total resistance.

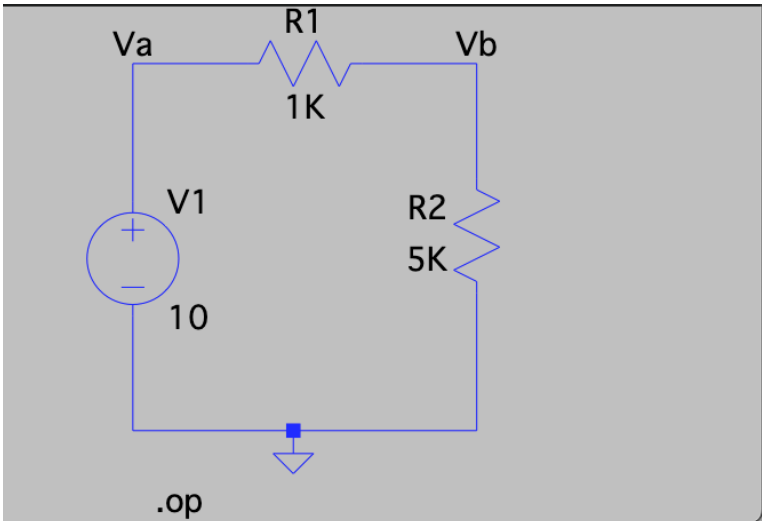
$$V_{out}\ = IR_n = \frac{E}{R_1 + R_2 + R_3 \ldots + R_n} * R_n$$

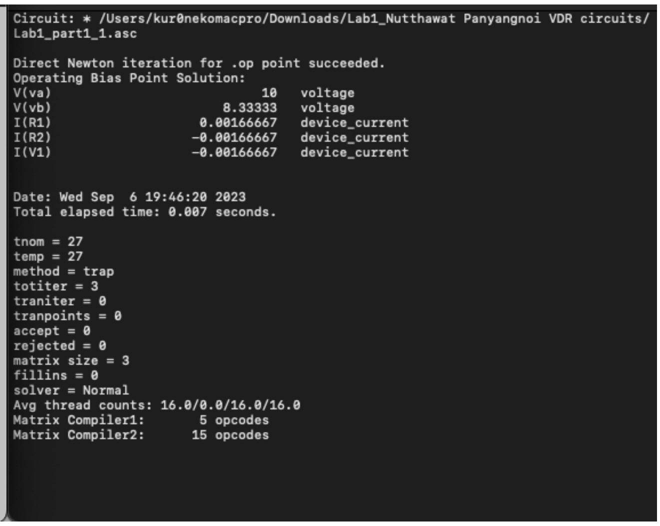
The Current Divider Rule states that the current in any of the parallel branches of a parallel circuit is equal to the ratio of opposite branch resistance to the sum of all resistances, multiple by the total current.

Branch current= total current $\frac{Resistance\ of\ opposite\ branch}{sum\ of\ ressitance\ of\ two\ branch}$

$$I_2 = I_{total} * \frac{R_1}{R_1 + R_2}$$

Part 1 LTSpice data:





V(R1) : V(R2) in Volt	V(R1)=1.666667 , V(R2)= 8.3 V
R1:R2 in KOhm	R1=1 Kohm = 1000 Ohms R2=5 KOhm = 5000 Ohms
Simplified ratio in integers	R1=1 : R2= 5 so 1:5 ratio
VDR confirm	Yes

<u>Verify the value from Calculation data to theoretical value</u>

Source =10 V connect in series with Resistors 1 kohm and 5 kohm.

$$V_{R1} = 10 * \left(\frac{1}{1+5}\right) = \frac{5}{3}V \approx 1.6667\ V$$

$$V_{R2} = 10 * \left(\frac{5}{5+1}\right) = \frac{25}{3}V \approx 8.3\ V$$

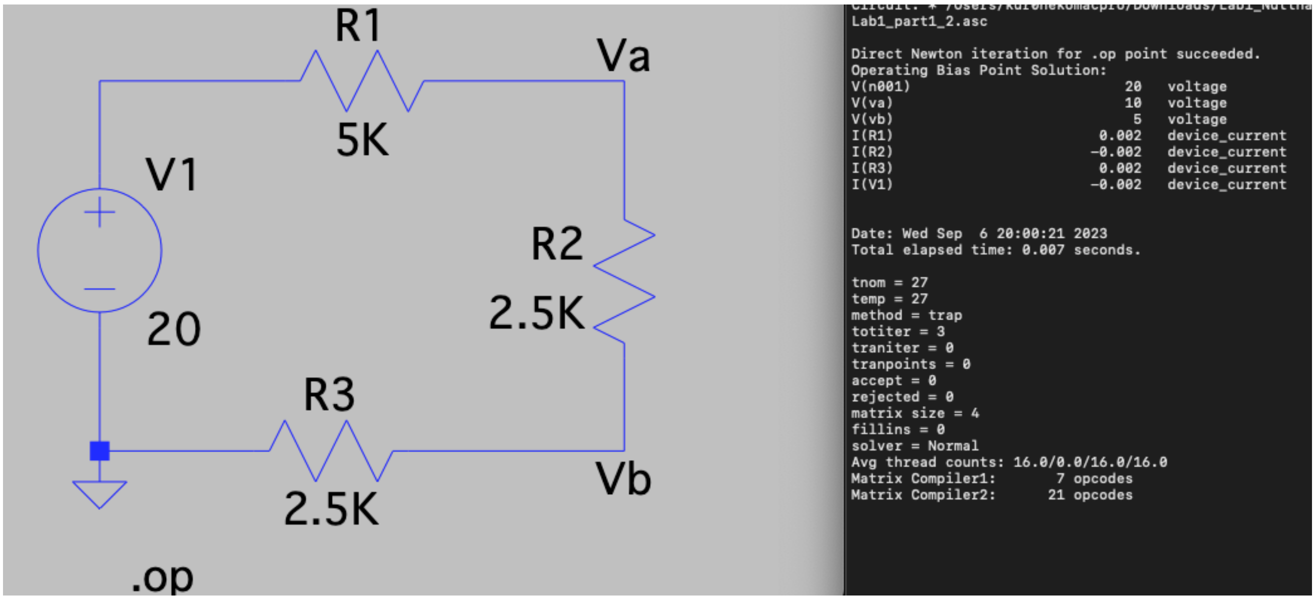
Ratio of Resistors $\frac{R_1}{R_2} = \frac{1}{5}$

Ratio in Voltage $\frac{VR_1}{VR_2} = \frac{\frac{5}{3}}{\left(\frac{25}{3}\right)} = \frac{1}{5}$

VDR confirmed because the ratio of voltages drops and resistors are equal hence voltage division rule is confirmed.

Hence, the result from LTspice is matches to the theoretical value

Part 2 LTSpice data:



V(R1) : V(R2) : V(R3) in Volt	(VR1)=10, V(VR2)=5V, V(R3)=5
R1:R2: R3 in KOhm	5 Kohm :2.5 Kohm :2.5 Kohm
Simplified ratio in integers	1 : ½ : ½
VDR confirm Yes or No	VDR YES

<u>Verify the value from Calculation data to theoretical value</u>

$$-20 + I(R_1) + I(R_2) + I(R_3) = 0 \quad \rightarrow \quad -20 + I((R_1) + (R_2) + (R_3)) = 0$$

$$-20 + I(5k + 2.5k + 2.5k) = 0 \quad \rightarrow \quad I = \frac{20}{10K}$$

$Therefore, we\ get\ I = 2mA \dashrightarrow I = 0.002\ A$ we can verify that the current value is correct.

Now we are finding voltage of each resistor.

$$V_{R1} = (IR_1) \dashrightarrow V_{R1} = (2 * 10^{-3})(5 * 10^{3}) = 10V$$

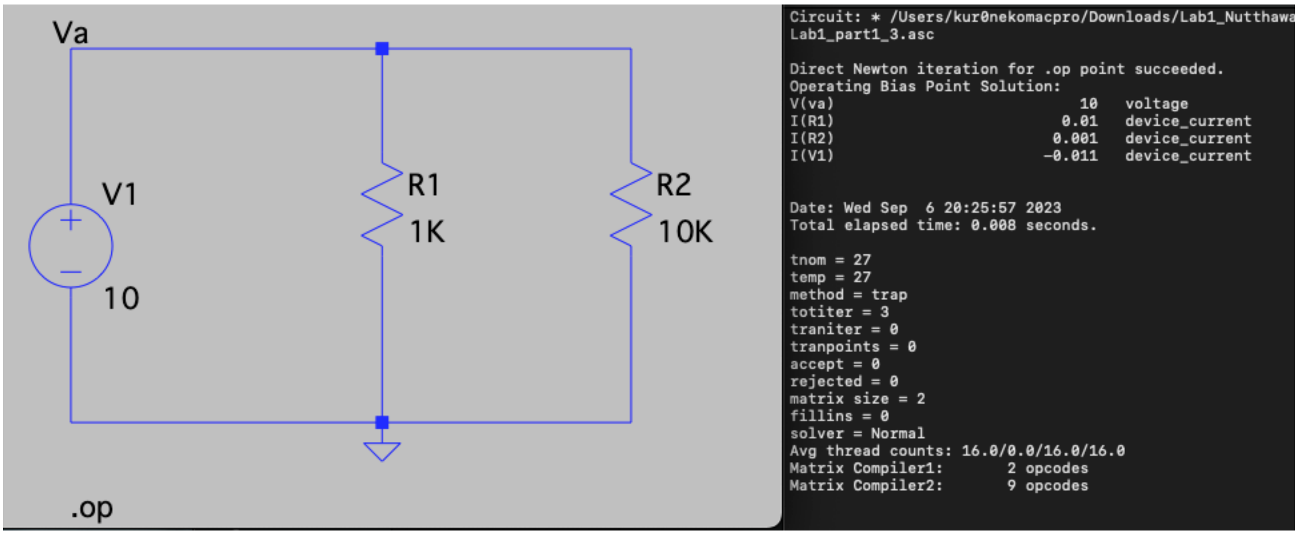
$$V_{R2} = (IR_2) \dashrightarrow V_{R2} = (2 * 10^{-3})(2.5 * 10^{3}) = 5V$$

$$V_{R3} = (IR_3) \dashrightarrow V_{R3} = (2 * 10^{-3})(2.5 * 10^{3}) = 5V$$

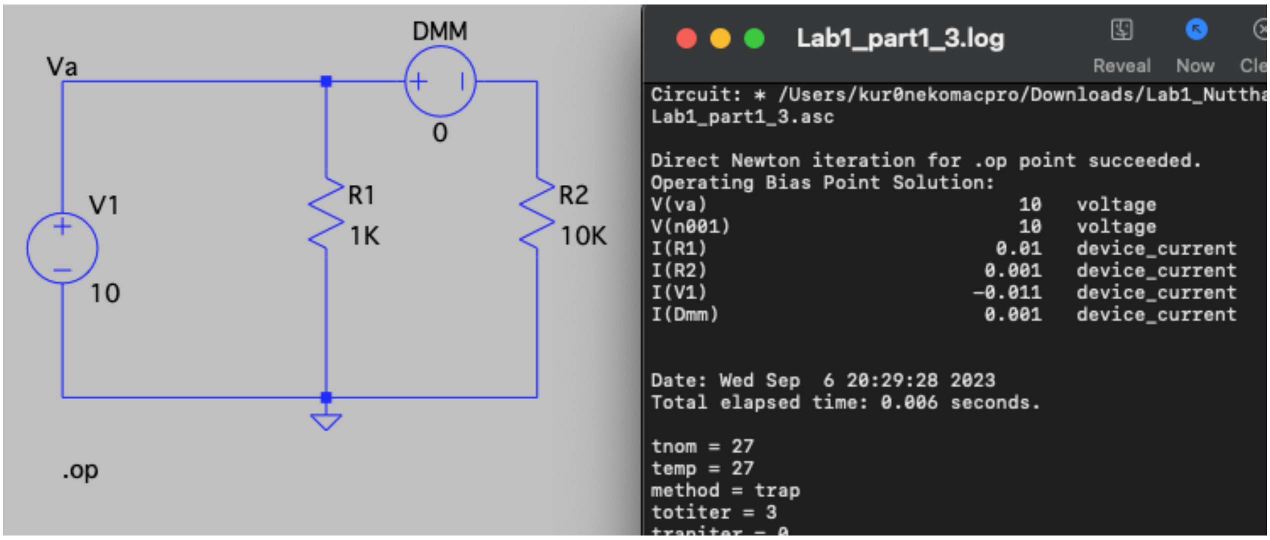
VDR is confirm due to voltage is divide between resistors based on the resistance drops.

Hence, the result from LTspice is matches to the theoretical value.

Part 3LTspice data:



<u>Using DMM method to check</u>



<u>**If the current value is negative is due to the polarity flipped which can be solved by flip polarity to the right side. We can check the polarity by using DMM.**</u>

I(R1):I(R2); units is in mA	I(R1)=10 mA and I(R2)= 1mA
Ratio of 1/R1: 1/R2 unit is in mMohn	1/1000= 0.001, 1/10000= 0.0001
Simplified ratio in integers	(1/R1):(1/R2)=10

<u>**The Current Divider Rule**</u> states that the current in any of the parallel branches of a parallel circuit is equal to the ratio of opposite branch resistance to the sum of all resistances, multiple by the total current.

$$I_2 = I_{total} * \left[\frac{R_2}{R_1 + R_2}\right]$$

Verify the value from Calculation data to theoretical value.

$$R_{eq} = \left[\frac{R1 * R2}{R1 + R2}\right] = \left[\frac{1000 * 10000}{1000 + 10000}\right] = 909.09\ \Omega$$

Find I_{total}

$$I_{total} = \left[\frac{V_1}{R_{eq}}\right] = \left[\frac{10}{909.09}\right] = 0.0110A = 11\ mA$$

Find current I_{R2} and I_{R1} by apply rule CDR.

$$I_{R2} = I_{total} * \left[\frac{R_1}{R_1 + R_2}\right]$$

$$I_{R2} = 11mA * \left[\frac{1000}{1000+10000}\right] = 1 \text{ mA}$$

$$I_{R1} = I_{total} * \left[\frac{R_2}{R_1 + R_2}\right]$$

$$I_{R1} = 11mA * \left[\frac{10000}{1000+10000}\right] = 01 \text{ mA}$$

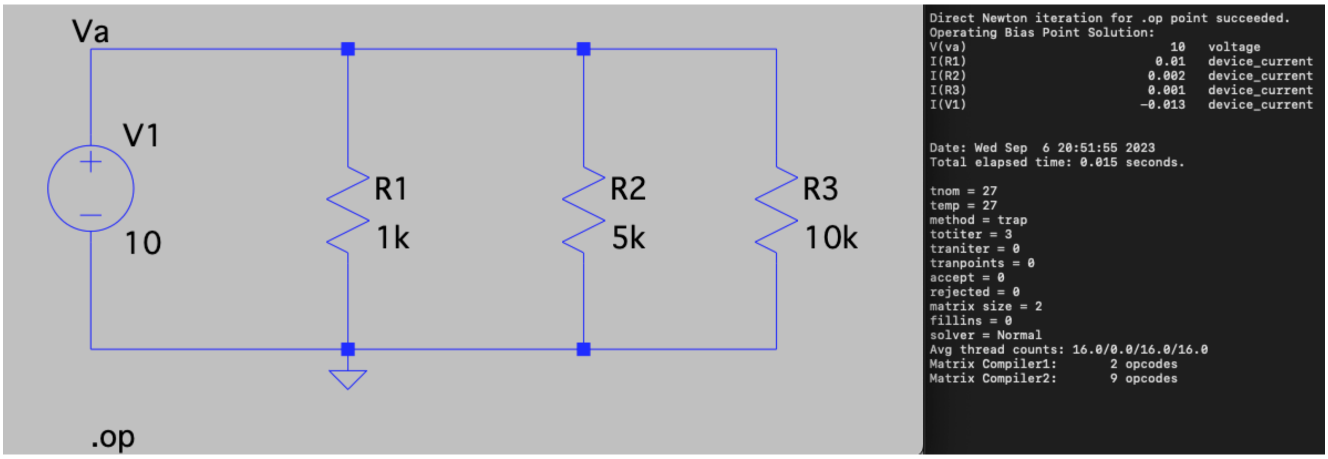
Calculate Ratio of $I_{R1}\ and\ I_{R2}$

$$I_{R1} + I_{R2} = \left(\frac{10mA}{1mA}\right) = 10$$

$$\frac{1}{R1} : \frac{1}{R2} = \left(\frac{(\frac{1}{1000})}{\frac{1}{10000}}\right) = 10$$

Hence, the result from LTspice is matches to the theoretical value.

Part 4LTspice data:



I(R1):I(R2):I(R3) units is in mA	I(R1)=10: I(R2)=2: I(R3)=1
Ratio of 1/R1: 1/R2:1/R3 unit is in mMohn	1/1000=0.001: 1/5000=0.0002: 1/10000=0.0001
Simplified ratio in integers	10:2:1
CDR confirm Yes or No	Yes

<u>Verify the value from Calculation data to theoretical value</u>

Apply Ohm's law $V = IR, I = \frac{V}{R}$

$$I(R1) = \frac{10}{1K} = 10\ mA$$

$$I(R2) = \frac{10}{5K} = 2\ mA$$

$$I(R3) = \frac{10}{10K} = 1\ mA$$

Calculate the ratio we obtain the mA is 10:2:1

Find $I_{total} = I_{R1} + I_{R2} + I_{R3}$ → = 10+2+1 = 13 mA

Apply CDR

$$I_{R1} = 13 * \left[\frac{10}{13}\right] \approx 10 \text{ mA}$$

$$I_{R2} = 13 * \left[\frac{2}{13}\right] \approx 2 \text{ mA}$$

$$I_{R1} = 13 * \left[\frac{1}{13}\right] \approx 1 \text{ mA}$$

CDR is verified due to the ration of current is the same per ratio of conductance.

Hence, the result from LTspice is matches to the theoretical value.