Faculty of Engineering & Technology

Department of Electrical & Computer Engineering

ENEE2103-CIRCUITS AND ELECTRONICS LABORATORY

Report#1

Experiment2: Circuit Laws and Theorems

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Abstract

The main goal of our experiment is to connect various electrical circuits, understand them, and clearly grasp concepts such as Kirchhoff's laws, voltage and current divider rules, Thevenin and Norton theorems, and learn how to take voltage and current measurements for different circuits.

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Theory

Kirchhoff's Circuit Laws

1- Kirchhoff's Current low

Kirchhoff's Current Law (KCL) is a key principle for analyzing electrical circuits. It basically says that at any point in a circuit where currents come together (node or junction), the total current flowing into that point must equal the total current flowing out.

KCL means:

The total current entering a node equals the total current leaving the node.

This concept helps figure out how currents are distributed in a circuit. By applying KCL to each junction in a circuit, and can set up equations that help to solve for unknown currents, and it can be tackled with methods like matrix calculations or nodal analysis. [1]

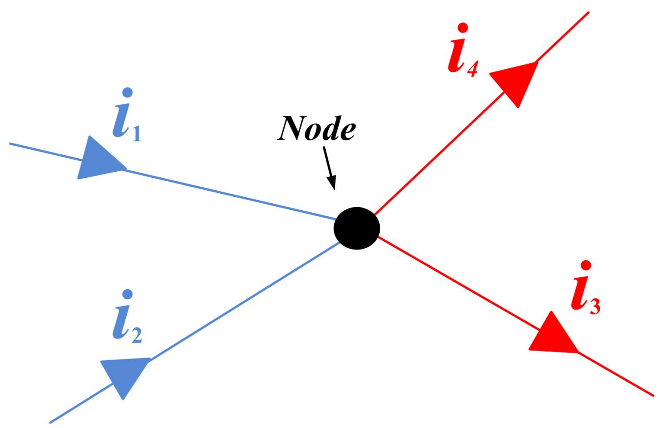
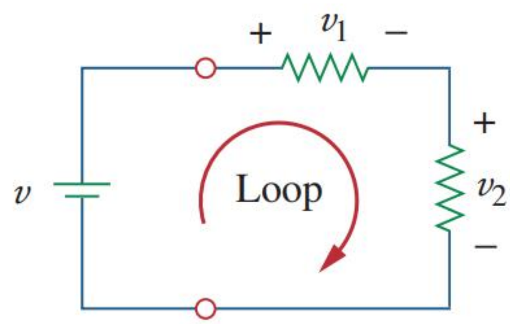


Figure 1:Node

2- Kirchhoff's Voltage low

Circuits with lumped parameters are analyzed using Kirchhoff's voltage and current laws. We are able to conduct a methodical study of any electrical network thanks to these laws and the voltage-current properties of the system's circuit parts. This section explains the voltage law of Kirchhoff.

The idea of a loop is central to KVL. A closed path in a circuit that doesn't pass through any nodes more than once is called a loop. Just begin at any node and follow a path across the circuit until you return to the starting point to construct a loop.[2]



$$KVL: -v + v_1 + v_2 = 0$$

Figure 2:Voltage low

Voltage and Current Division

1- Voltage Division

A voltage divider is a passive linear circuit that produces an output voltage (Vout) that is a fraction of its input voltage (Vin). This happens by distributing the input voltage among the components of the divider. A simple example is two resistors connected in series, with the input voltage applied across the pair and the output voltage taken from the junction between them.

Resistor voltage dividers are often used to create reference voltages or to reduce voltage levels for measurement purposes. They can also function as signal attenuators at low frequencies. For direct current (DC) and relatively low frequencies, a resistor-only voltage divider can be accurate enough. However, for applications requiring a wide frequency response, such as in oscilloscope probes, capacitive elements are added to the divider to compensate for load capacitance. In high-voltage measurement in electric power transmission, a capacitive voltage divider is used. [3]

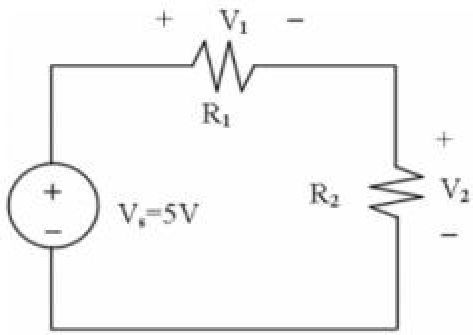


Figure 3:Voltage Divider

2- Current Division

A current divider is a straightforward linear circuit that produces an output current (IX) that is a fraction of its input current (IT). This process involves splitting the input current between the branches of the divider. The currents in these branches divide in such a way as to minimize the total energy expended.

There is one significant distinction between the formulas for current and voltage dividers. The branch's impedance is in the denominator of a current divider as opposed to the numerator of a voltage divider. This is because current travels through the least impedance channels in current dividers, resulting in an inverse relationship with impedance. In contrast, Kirchhoff's Voltage Law (KVL), which calls for dividing voltage decreases proportionate to the impedance, is the foundation of a voltage divider.

When two or more impedances are in parallel, the current splits between them inversely proportional to their impedances, as per Ohm's law. If the impedances are equal, the current will be split equally between the branches.[4]

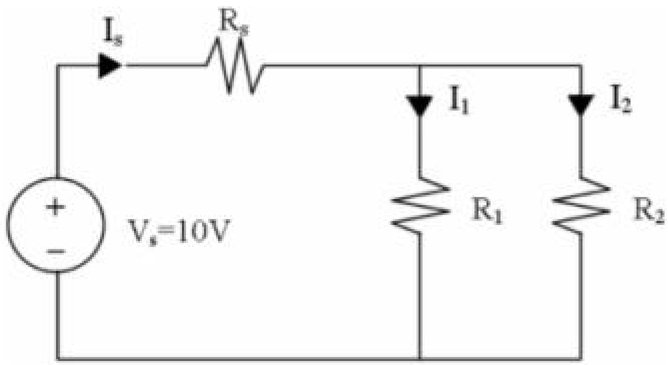


Figure 4:Current Divider

Superposition

The net response induced by two or more stimuli in any linear system is equal to the sum of the responses that would have been induced by each stimulus separately, according to the superposition principle, also called the superposition property. For input (A + B) to produce response (X + Y), if input A produces response X and input B produces response Y. [5]

To use the superposition principle, follow these steps:

1. All but one independent source should be turned off (deactivated).

2. Determine the output (current or voltage) from that source.

3. For each of the additional independent sources, repeat step 1.

4. Add up all of the voltages or currents from each independent source to find the total (voltage or current).

Thevenin and Norton equivalent circuits

1) Thevenin Equivalent Circuit

A single voltage source (Thevenin voltage) in series with a single resistor (Thevenin resistance) can be used to substitute a circuit with two terminals.The Thevenin resistance value is the corresponding resistance when viewed in retrospect.

network at the terminals for output. The open circuit voltage at the output terminals, with all voltage sources substituted with shorts and all current sources substituted with opens, is the value of the Thevenin voltage. [6]

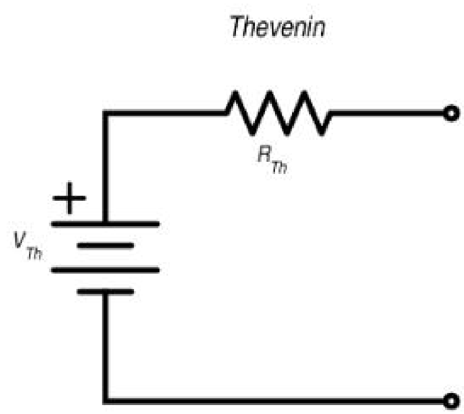


Figure 5:Thevenin Equivalent Circuit

2) Norton Equivalent Circuit

A single current source (Norton current) in parallel with a single resistor (Norton resistance) can be used to substitute a circuit with two terminals. The Norton resistance's value is the corresponding resistance when examining the

network at the terminals for output. The short circuit current at the output terminals, with every voltage source substituted by a short and every current source substituted by an open, is the Norton current. [7]

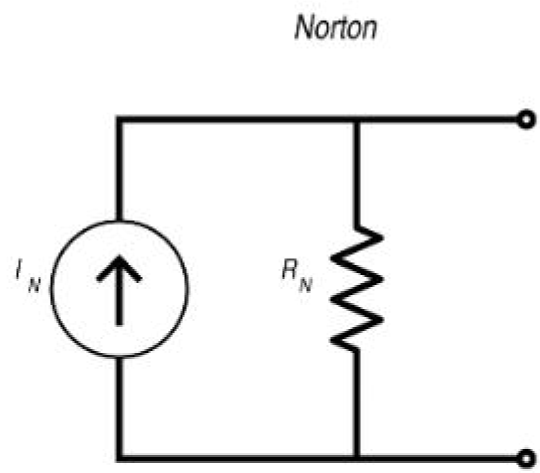


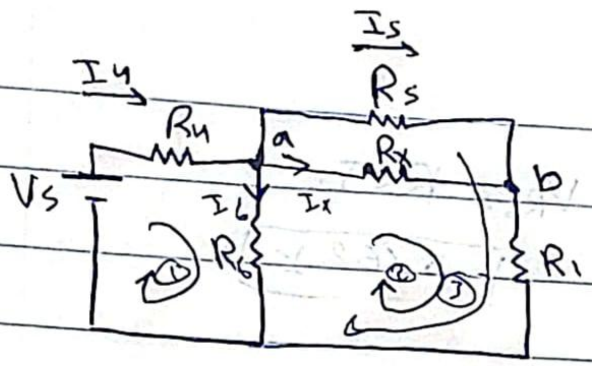
Figure 6:Norton Equivalent Circuit

Procedure and Discussion

A. KVL, KCL

- Hand Calculation

R5 = 3.3K , R6 = 4.7K , R1 = R4 = RX = 1K ,Vs = 15V



For $R_x = 1k$

KCL:

$\Rightarrow$ KCL at node b

$I_1 = I_s + I_x$ ---(1)

$\Rightarrow$ KCL at node a

$I_4 = I_s + I_x + I_6$

KVL:

$\Rightarrow$ KVL at loop(1):-

$15 = 1k\,I_4 + 4.7k\,I_6$ ---(3)

$\Rightarrow$ KVL at loop(2)

$I_x\,1k + I_1\,1k - 4.7k\,I_6 = 0$ ---(4)

$\Rightarrow$ KVL at loop(3)

$3.3k\,I_s + 1k\,I_1 - 4.7k\,I_6 = 0$ ---(5)

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Using (1) & (4)

$I_x 1k + I_s 1k + I_x 1k - 4.7k I_6 = 0$

$I_x 2k + I_s 1k - 4.7 I_6 = 0$ —— (6)

Using (1) & (5)

$3.3k I_s + 1k I_s + 1k I_x - 4.7k I_6 = 0$

$4.3k I_s + 1k I_x - 4.7k I_6 = 0$ —— (7)

Using (6) & (7)

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$+2k I_x + I_s 1k - 4.7k I_6 = 0$

$-2[4.3k I_s + 1k I_x - 4.7k I_6 = 0]$

$\Rightarrow 2k \cancel{I_x} + I_s 1k - 4.7k I_6 = 0$

$(+)\ -8.6k I_s - \cancel{2k I_x} + 9.4k I_6 = 0$

$\Rightarrow -7.6 I_s + 4.7 I_6 = 0$

$4.7 I_6 = 7.6 I_s$

$I_6 = 1.617 I_s$ —— (8)

Using ⑤ & ⑥

$2k I_x + I_s 1k - 4.7(1.617 I_s) = 0$

$2k I_x + I_s 1k - 7.5999 I_s = 0$

$2k I_x - 6.5999 I_s = 0$

$2k I_x = 6.5999 I_s$

$\therefore I_x = 3.29995 I_s$ — ⑨

Using ⑧ & ⑨ & ⑦

$I_4 = I_s + 3.29995 I_s + 1.617 I_s$

$I_4 = 5.91695 I_s$ — ⑩

Using ⑩ & ⑧ & ③

$I_s = 1k I_4 + 4.7k I_6$

$I_s = 1k(5.91695 I_s) + 4.7k(1.617 I_s)$

$I_s = 5.91695k I_s + 7.5999k I_s$

$I_s = 13.51685k I_s$

$\boxed{I_s = 1.10973 mA}$ $\boxed{I_4 = 6.566 mA}$ $\boxed{I_x = 3.662 mA}$

$\boxed{I_6 = 1.794 mA}$ $\boxed{I_1 = 4.7717 mA}$

$V_{R_1} = R_1 I_1$

$\boxed{= 4.7717\,v}$

$V_{R_5} = R_5 I_5$

$\boxed{= 3.662\,v}$

$V_{R_6} = R_6 I_6$

$\boxed{= 8.4318\,v}$

$V_{R_4} = R_4 I_4$

$\boxed{= 6.566\,v}$

$V_{R_x} = R_x I_x$

$\boxed{= 3.662\,V}$

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R5 = 3.3K,R6 = 4.7K ,R1 = R4 = 1K ,Rx = 0.5K ,Vs = 15V

Using the same calculation above but for Rx = 0.5K

Vs(Volt)	Rx	R1		R4		R5		R6		Rx	
		V1	I1	V4	I4	V5	I5	V6	I6	Vx	Ix
15V	**1K**	4.7717v	4.7717mA	6.566v	6.566mA	3.662v	1.10973mA	8.4318v	1.794mA	3.662v	3.662mA
15V	**0.5K**	5.4755v	5.4755mA	7.1466v	7.1466mA	2.378v	0.7205mA	7.85323v	1.6709mA	2.3775v	4.755mA

Table 1:Voltages and Currents for Theoretical KVL, KCL circuits

- practical

Initially, we verified that the resistance values provided corresponded to those in the lab handbook using a digital multimeter. After making sure of this, we assembled the circuit for this part, took measurements, and entered the results into a table. We accomplished this by measuring the voltage across the resistors in parallel and the current passing through them in series using the multimeter. We performed the tests again using a variable resistor set to 0.5 kilo-ohms in place of the 1 kilo-ohm resistor .

Vs(Volt)	**Rx**	**R1**		**R4**		**R5**		**R6**		**Rx**	
		V1	**I1**	**V4**	**I4**	**V5**	**I5**	**V6**	**I6**	**Vx**	**Ix**
15V	**1K**	4.7v	4.8mA	6.5v	8.8mA	4.7v	1.1mA	8.4v	1.3mA	3.8v	3.6mA
15V	**0.5K**	5.4v	5.5mA	7.1v	10.6mA	5.4v	0.8mA	7.8v	0.9mA	2.4v	4.7mA

Table 2Table 2:Voltages and Currents for practical KVL, KCL circuits

-Discussion

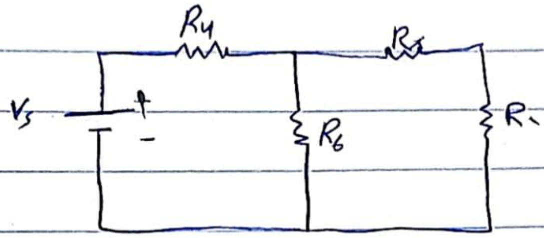
The two tables show how closely the values discovered attach the theoretical calculations. This shows the accuracy of the theory of Kirchhoff's laws, as we know. However, certain differences exist. For example, Table 2's I4 value varies because to circuit overloading.

B. Voltage & Current Division

I. Voltage division

- Hand Calculation

R5 = 3.3K , R6 = 4.7K ,R1 = R4 = 1K ,Rx=1K , Vs = 10V



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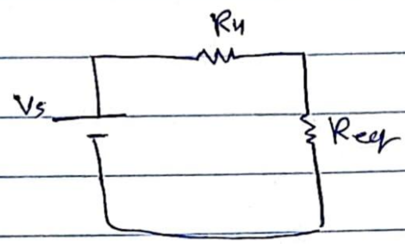

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⇒ for $R_x = 1k$.

$$R_{eq} = (R_x + R_1) // R_6$$
$$\boxed{= 1.4029\,k\Omega}$$

Voltage divider at R4

$$V_{R4} = \frac{R_4}{R_{eq} + R_4} \cdot V_s$$

$$= \frac{1}{1.4029 + 1} \cdot 10 = \boxed{4.1616V}$$

Voltage divider at Req

$$V_{Req} = \frac{R_{eq}}{R_{eq}+R_4} \cdot V_S$$

$$= \frac{1.4029}{1.4029+1} \cdot 10$$

$$\boxed{= 5.838V}$$

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$$V_{R6} = V_{Req} \boxed{= 5.838V}$$

Voltage divider for Rx

$$V_{Rx} = \frac{R_x}{R_x+R_1} V_{Req}$$

$$= \frac{1 \cdot 5.838}{1+1} = \boxed{2.919v}$$

Voltage divider for R1

$$V_{R1} = \frac{R_1}{R_1+R_x} \cdot V_{Req}$$

$$= \frac{1 \cdot 5.838}{1+1} \boxed{= 2.919V}$$

R5 = 3.3K , R6 = 4.7K ,R1 = R4 = 1K , Rx=0.5K, Vs = 10V

Using the same calculation above but for Rx = 0.5K

Vs(Volt)	Rx	V1	V4	V6	Vx
10v	1K	2.919v	4.1616v	5.838v	2.919v
10v	0.5K	3.547v	4.679v	5.32v	1.773v

Table 3:Voltages for Theoretical voltage division circuits

- practical

Initially, we assembled the circuit for this part, took measurements, and entered the results into a table. We accomplished this by using the digital multimeter in parallel with a voltage meter, one may measure the voltage near the resistors in the circuit.We performed the tests again using a variable resistor set to 0.5 kilo-ohms in place of the 1 kilo-ohm resistor .

Vs(Volt)	**Rx**	**V1**	**V4**	**V6**	**Vx**
10v	1K	2.9v	4.1v	5.9v	2.9v
10v	0.5K	3.5v	4.6v	5.3v	1.8v

Table 4:Voltages for practical voltage division circuit

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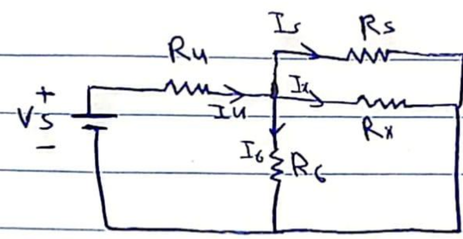
-Discussion

The two tables show how closely the values discovered attach the theoretical calculations. This shows the accuracy of the theory of Voltage division laws ,we know before are accurate.

II. Current division

- Hand Calculation

R5 = 3.3K , R6 = 4.7K ,R1 = R4 = 1K,Rx=1k , Vs = 15V



for $R_x = 1k\Omega$

$R_{eq} = R_4 + (R_5 // R_x // R_6)$

$\boxed{= 1.6597 \ k\Omega}$

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$I_4 = \frac{V_s}{R_{eq}} = \frac{10}{1.6597} \boxed{= 6.025 \ mA}$

current divider (R_5)

$I_5 = \frac{R_x // R_6}{(R_x // R_6) + R_5} * I_4$

$= \frac{0.82456}{4.12456} * 6.025$

$\boxed{= 1.2045 \ mA}$

current divider (R_6)

$$I_6 = \frac{R_5 // R_x}{(R_5 // R_x) + R_6} * I_4$$

$$= \frac{0.77}{5.47} * 6.025$$

$$\boxed{= 0.848 mA}$$

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~~[illegible]~~

current divider (R_x)

$$I_x = \frac{R_5 // R_6}{(R_5 // R_6) + R_x} * I_4$$

$$= \frac{1.98375}{2.93875} * 6.025$$

$$\boxed{= 3.9748 mA}$$

R5 = 3.3K , R6 = 4.7K ,R1 = R4 = 1K,Rx=0.5k , Vs = 15V

Using the same calculation above but for Rx = 0.5K

Vs(volt)	Rx	I4	I5	I6	Ix
10	1K	6.025mA	1.2045mA	0.848mA	3.9748mA
10	0.5K	7.1556mA	0.8619mA	0.605mA	5.6885mA

Table 5:Currents for Theoretical Current division circuits

- practical

Initially, we assembled the circuit for this part, took measurements, and recorded the results in a table. We measured the current passing through the resistors in the circuit using a digital multimeter in series with a current meter. We then repeated the tests using a variable resistor set to 0.5 kilo-ohms in place of the 1 kilo-ohm resistor.

Vs(volt)	Rx	I4	I5	I6	Ix
10	1K	6mA	1.2mA	0.8mA	4.01mA
10	0.5K	7.2mA	0.86mA	0.6mA	5.7mA

Table 6:Currents for Practical Current division circuits

-Discussion

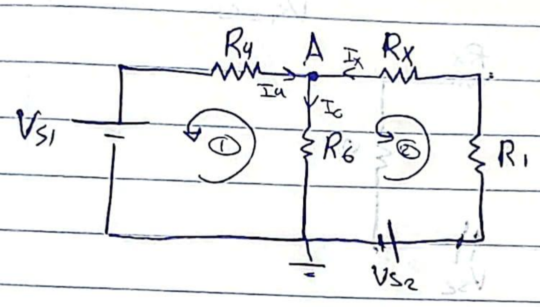
As we can see, the results in the two tables above are getting closer to one another. Our laboratory results are roughly equal to the result of our hand computations. By doing this, the circuit's current division validity is confirmed.

C. Superposition

- Hand Calculation

R5 = 3.3K , R6 = 4.7K , R1 = R4 = Rx = 1K

1



$V_{s_1} = 5V,\ V_{s_2} = 10V$

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KCL (A)

$I_6 = I_4 + I_x$

$I_4 = I_6 - I_x$ --- 1

KVL 1

$5 = 1k\, I_4 + 4.7k\, I_6$

using 1

$5 = 1k(I_6 - I_x) + 4.7k\, I_6$

$5 = 1k\, I_6 - 1k\, I_x + 4.7k\, I_6$

$5 = 5.7k\, I_6 - 1k\, I_x$ --- 2

2

KVL(2)

$10 = I_x 1k + I_1 1k + 4.7k I_6$

$10 = 2k I_x + 4.7k I_6 \rightsquigarrow (1)$

3 & 2

$2\,[5 = 5.7k I_6 - 1k I_x]$

$+\ 10 = 2k I_x + 4.7k I_6$

$10 = 11.4k I_6 - \cancel{2k I_x}$

$10 = \cancel{2k I_x} + 4.7k I_6$

$20 = 16.1k I_6$

$\boxed{I_6 = 1.242\,mA}$

$V_{R_1} = I_6 R_6$

$\boxed{= 5.8385\,V}$

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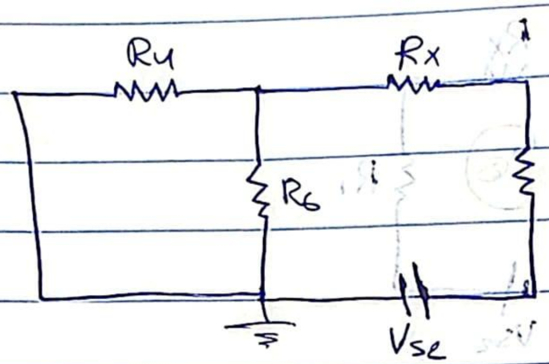
③

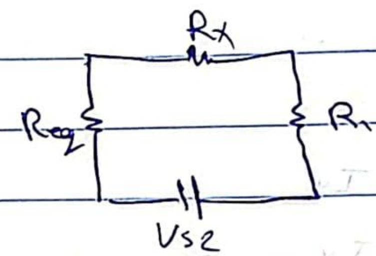
$V_{S1} = 0$



$V_{S1} = 0$ & $V_{S2} = 10V$

$R_{eq} = R_4 \| R_6$

$= 0.8245k$



$V_{Req} = \frac{R_{eq}}{R_{eq}+R_x+R_1} \times V_{S2}$

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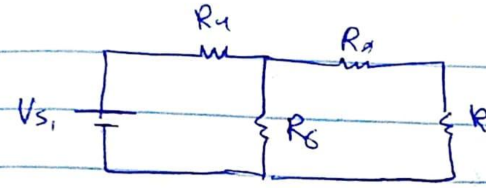
$\boxed{= 2.919V = V_{R6}}$

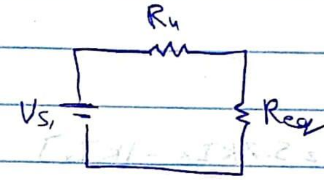
$I_6 = \frac{V_{R6}}{R_6} = \frac{2.919V}{4.7k} \boxed{= 0.62\,mA}$

(4)



$V_{s2}=0$

$V_{s1} = 5V$ & $V_{s2} = 0$



$R_{eq} = (R_2 + R_1) // R_6$

$= 1.40299\,k$

$V_{Req} = \frac{R_{eq}}{R_{eq} + R_4} \cdot V_{s1}$

$\boxed{= 2.919V = V_{R6}}$

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$I_6 = \frac{V_{R6}}{R_6} = \frac{2.919V}{4.7V} \boxed{= 0.62mA}$

Vs1(volt)	Vs2(Volt)	V6(Volt)	I6(mA)
5	10	5.8385	1.242
0	10	2.919	0.62
5	0	2.919	0.62

Table 7:Voltages and Currents for Theoretical Superposition Circuit

- practical

In this part, firstly we connected the circuit needed with two voltage sources, Vs1 and Vs2, and then measured the voltage around R6 using a digital multimeter connected as a voltmeter in parallel to the resistor R6. Then we measured the current through the same resistor using another digital multimeter connected as an ammeter in series with the resistor.We then replaced Vs1 with a short circuit to kill Vs1, and we monitored the voltage and current as before. The final stage involved killing Vs2 by substituting a short circuit for Vs2, and then measuring the voltage and current as previously.

Vs1(volt)	Vs2(Volt)	V6(Volt)	I6(mA)
5	10	5.8	1.24
0	10	2.8	0.6
5	0	2.9	0.6

Table 8:Voltages and Currents for practical Superposition Circuit

-Discussion

As we can see from tables, the values obtained in the laboratory are closely matched with those from our hand calculations. This verifies the validity of superposition for the circuit. This close match proves that the theory behind superposition, as demonstrated in the theory section, is sound.

D. Thevenin and Norton equivalent circuits

- Hand Calculation

R5 = 3.3K , R6 = 4.7K , R1 = R4 = Rx = 1K , Vs1 = 5V ,Vs2 = 10V

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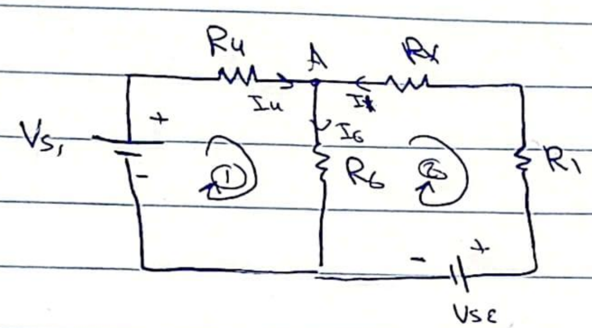

KCL(A)

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$I_6 = I_4 + I_1$ — ①

KVL ①

$5 = 1k\,I_4 + 4.7k\,I_6$

$5 = 1k\,I_4 + 4.7k\,(I_4 + I_1)$

$5 = 1k\,I_4 + 4.7k\,I_4 + 4.7k\,I_1$

$5 = 5.7k\,I_4 + 4.7k\,I_1$ — ②

KVL ②

$10 = I_1 1k + I_1 1k + 4.7\,I_6$

$10 = I_1 1k + I_1 1k + 4.7k\,(I_4 + I_1)$

$10 = 2k\,I_1 + 4.7k\,I_4 + 4.7k\,I_1$

$10 = 6.7k\,I_1 + 4.7k\,I_4$ — ③

2

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$[5 = 5.7k I_4 + 4.7k I_1] \times -4.7$

$[10 = 6.7k I_1 + 4.7k I_4] \times 5.7$

$-23.5 = \cancel{-26.79 I_4} - 22.09 I_1$ هلا محمد

$57 = 38.19 I_1 + \cancel{26.79 I_4}$ 1210312

$33.5 = 16.1 I_1$

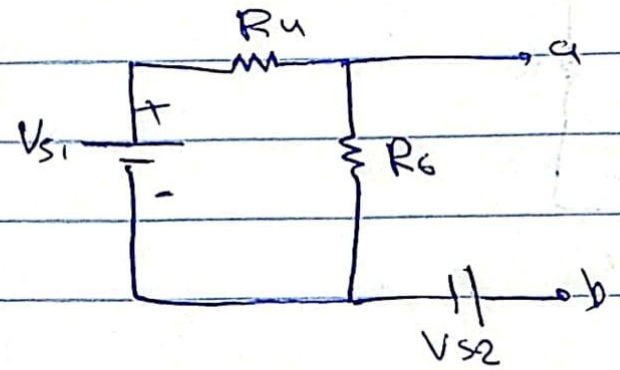
$\boxed{I_1 = 2.08\,mA}$

$V_{R_1} = R_1 I_1$

$\boxed{= 2.08\,V}$

3

$V_{ab1} =$



$$V_{R_6} = \frac{R_6}{R_6 + R_4} \cdot V_{S1}$$

$$= \frac{4.7 \times 5}{4.7 + 1}$$

$$\boxed{= 4.1228\ V}$$

$V_{ab} = V_{S2} - V_{R_2}$

$$\boxed{= 5.8772\ V}$$

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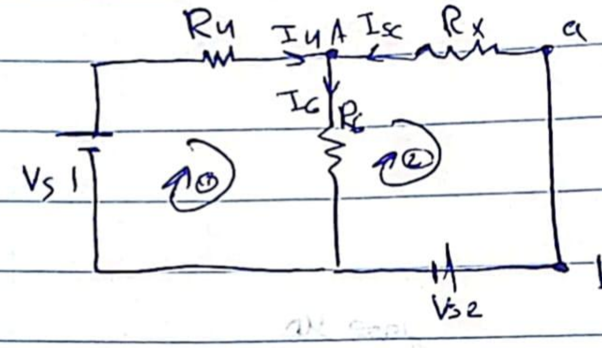
(4)

I_{sc} :-



KCL(A)

$I_6 = I_{sc} + I_4$ —— ①

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KVL①

$5 = I_4\,1k + 4.7k\,I_6$

$5 = I_4\,1k + 4.7k(I_{sc} + I_4)$

$5 = I_4\,1k + 4.7k\,I_{sc} + 4.7\,I_4$

$5 = 5.7\,I_4 + 4.7k\,I_{sc}$ —— ②

KVL②

$10 = 1k\,I_{sc} + 4.7k\,I_6$

$10 = 5.7k\,I_{sc} + 4.7k\,I_4$ —— ③

(3)

(2) + (3)

$[5 = 5.7 I_4 + 4.7k\, I_{sc}] \cdot -4.7$

$[10 = 5.7k\, I_{sc} + 4.7k\, I_4]\, 5.7$

$-23.5 = \cancel{-26.79k\, I_4} - 22.09\, I_{sc}$

$57 = 32.49k\, I_{sc} + \cancel{26.79k\, I_4}$

$33.5 = 10.4k\, I_{sc}$

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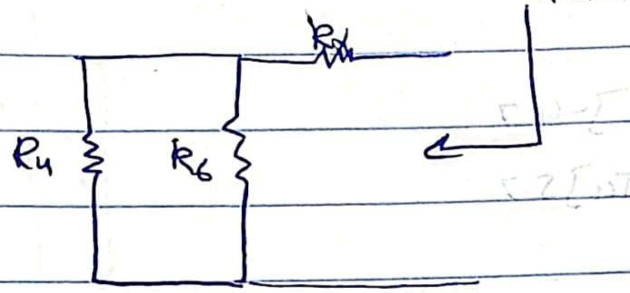
$\boxed{I_{sc} = 3.221\, mA}$

⑥

R_{th}:-



$R_{th} = (R_4 \| R_6) + R_7$

$\boxed{= 1.8246k}$

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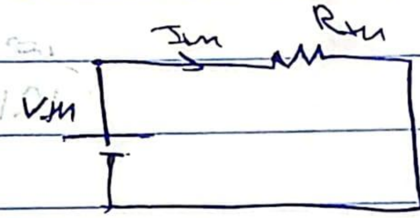
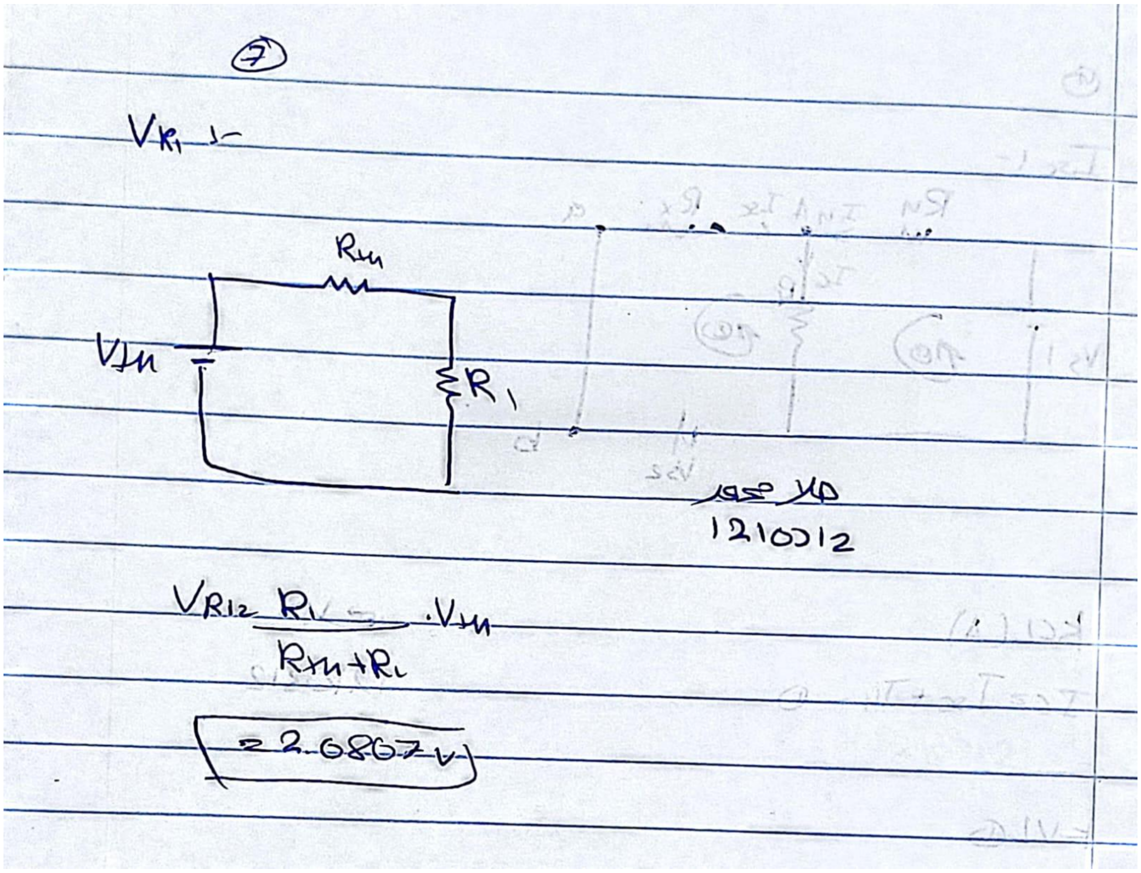
I_{th}:-



$I_{th} = \dfrac{V_{th}}{R_{th}} = \dfrac{5.8772V}{1.8246K}$

$\boxed{= 3.221 mA}$



VR1	2.0807V
Voc	5.8772 V
Isc	3.221 mA
Rth	1.8246K

Table 9:Data for Theoretical Thevenin and Norton equivalent circuits

- practical

In this section, we first connected the circuit to two voltage sources, Vs1 and Vs2, and then we measured the voltage surrounding R1 using a digital multimeter that was connected in parallel to R1 as a voltmeter. Once R1 was unplugged, we measured the voltage at the terminals (a, b) to which R1 was attached. The short-circuit current (Isc) via the same terminals was then measured. Next, the voltage sources were cut off, and a short circuit was made to find Rth. Finally, we connected R1 and measured the voltage across it after connecting Rth and Vth and measuring the current via the short circuit.

Here we got negative values because we were reversing the polarities during the measurement process

VR1	-2V
Voc	-5.9V
Isc	-3.2 mA
Rth	1.8K

Table 10:Data for practical Thevenin and Norton equivalent circuits

-Discussion

Our experimental values closely match theoretical calculations, as tables demonstrate, demonstrating the accuracy of the Norton and Thevenin equivalent circuits. Thevenin equivalent produces the same output as the original circuit, and the manual calculations and lab findings match up nicely.

Conclusion

In conclusion, we demonstrated the validity of the Superposition theorem, the Thevenin and Norton equivalent circuits, the division rules for voltage and current, and Kirchhoff's laws (KVL and KCL). We gained knowledge on how to build practical circuits in the lab. We gained the know-how and abilities required to measure resistances, voltages, and currents while operating the equipment safely. The division rules for voltage and current, the applicability of the superposition theorem, and the operation of Kirchhoff's voltage and current laws were all verified. Finally, the circuits that corresponded to Thevenin and Norton were found.

References

[1] https://www.electronics-tutorials.ws/dccircuits/kirchhoffs-current-law.html

accessed on 21/7/2027 at 8:08pm

[2] https://digilent.com/reference/learn/fundamentals/circuits/kirchhoffs-voltage-law/start

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[3] https://en.wikipedia.org/wiki/Voltage_divider

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[4] https://en.wikipedia.org/wiki/Current_divider

accessed on 21/7/2027 at 7:56pm

[5] https://en.wikipedia.org/wiki/Superposition_principle

accessed on 21/7/2027 at 8:24pm

[6] https://en.wikipedia.org/wiki/Th%C3%A9venin%27s_theorem

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[7] https://en.wikipedia.org/wiki/Norton%27s_theorem

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Appendix

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11:00

Circuits & Electronics Lab Hamza Barhosh 1210920 ENEE2103

Hala Mohammed

Experiment#2 ENEE2103

Circuit Laws and Theorems

Objectives:

1. To use to measure the resistance, the voltage and the current.
2. To test the validity of the KVL and KCL laws.
3. To verify the validity of the voltage and current division rules.
4. To test the validity of the superposition theorem.
5. To determine the Thevinin and Norton equivalent circuits.

R_1 = .9832 kΩ

R_2 = .9936 kΩ

R_3 = 3.236 kΩ

R_4 = 4.7 kΩ

Equipment:

1. Digital Multimeter.
2. Feedback Prototype Board
3. DC power supply
4. Discrete Resistors, Resistance Decade Box

Pre-lab:

1. Simulate the circuits in the procedure section and determine the required values (set the parameters that must be assigned by the instructor in the procedure to proper values).
2. Verify if Simulation Results match the expected results

Procedure:

A. KVL,KCL

1. Measure the value of the resistances given to you by the lab instructor and make sure they match those in Fig. (2.1)
2. Connect the circuit of Fig (2.1). **Consider Rx=R1=R4=1kΩ , R5=3.3kΩ,R6=4.7kΩ**
3. Set the voltage source to 15 volts
4. Set the resistance decade box R_x to the value 1kΩ .
5. Measure and fill the values required in table 2.1(value and sign according to the used sign convention).
6. Change the value of R_x to the half of the first value.
7. Reapeat step 5
8. From your measurements verify the validity of KCL , KVL for the circuit.

Keep the circuit connected for the following part.

Table (2.1)

Vs	Pot	R1		R4		R5		R6		Rx	
		V1	I1	V4	I4	V5	I5	V6	I6	Vx	Ix
15V	Rx	4.7	4.8	6.5	8.8	[illegible]	1.1	8.4	1.3	3.8	3.6
15V	0.5 Rx	5.4	5.5	7.1	10.6	5.4	.8	7.8	.9	2.4	[illegible]

4.7

overload

4.7

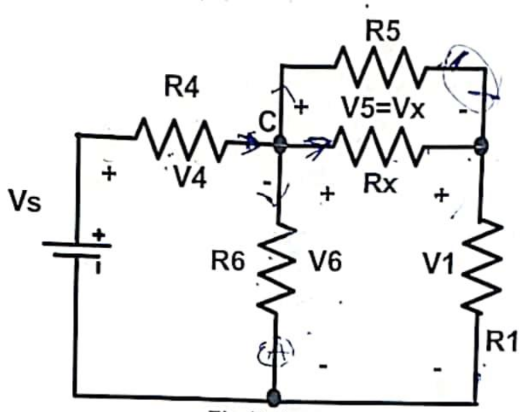


Fig (2.1)

B. Voltage & Current Division:

I. Voltage division

1. In the circuit of Fig (2.1) disconnect the resistance R_5 from the circuit
2. Measure the voltages on all the branches of the circuit.
3. Change R_x as shown in table2.2 and repeat step2 for all the given values.
4. In each case apply the resistors values into the voltage division formula
9. Do the measured values satisfy the voltage division rule? **Keep the circuit connected for the following part.**

Table (2.2)

Vs (volt)	Pot.	V1	V4	V6	Vx
10	Rx	2.9	4.1	5.9	2.9
10	0.5Rx	3.5	4.6	5.3	1.8

II. Current division

1. In the circuit of Fig (2.1) reconnect R_5 and replace R1 by a short circuit and set R_x to its start value.
2. Measure the curents in all the resistive branches of the circuit and fill the values in table2.3.
3. Change R_x as shown in table 3 and repeat step 2 for all the given values.
4. In each case apply the resistors values into the current division formula
5. Do the measured values satisfy the theoretical values of the current division rule?

Table (2.3)

mA

Vs (volt)	Pot.	I4	I5	I6	Ix
10	Rx	6	1.2	.8	4.01
10	0.5Rx	7.2	.86	.6	5.7

C. Superposition:

1. Connect the circuit of Fig (2.2).
2. Set the source V_{s1} to 5 volts and V_{s2} to 10 volts.
3. Set the variable resistor R_x to the value of 1K.
4. Measure the current and the voltage on R_6
5. Set V_{S1} to zero and V_{s2} to 10 volts measure the current and the voltage on R_6
6. Set V_{s1} to 5 volts and V_{s2} to zero and measure the current and the voltage on R_6
7. Define the relation between the three current values measured in (4,5,6)
8. Define the relation between the three voltage values measured in (4,5,6)

Table (2.4)

Vs1(volt)	Vs2 (volt)	V6 (volt)	I6 (mA)
5	10	5.8	1.24
0	10	2.8	0.6
5	0	2.9	0.6

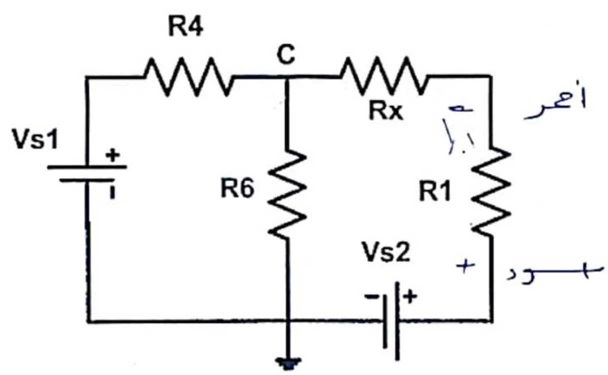
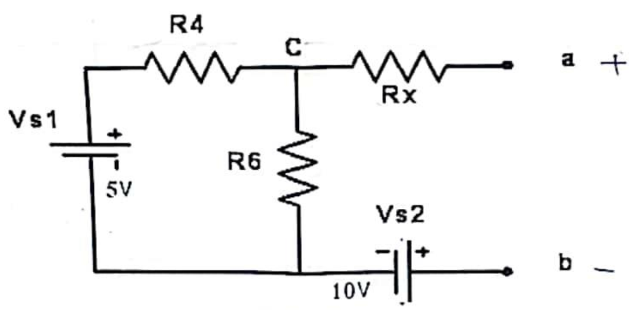


Fig (2.2)

D. Thevinin and Norton equivalent circuits:

1. Reconnect the circuit of Fig (2.2). V: -2V
2. Set the V_{s1} to 5volts and Vs2 to 10 volts and measue voltage across R1.
3. Disconnect R_1 and measure the voltage on the terminals (a,b) where R_1 was connected as in Fig (2.3).[Voc- open circuit voltage] V: -5.9V
4. Short circuit the terminals (a, b) and measure the current in the short circuit (Isc). I_{sc}: -3.2
5. Disconnect the voltage sources and short circuit the terminals where each source was connected. R: 1.8

6. Measure the resistance from the terminals (a,b) (Rab=Rth). 1.8
7. Connect the voltage source in series with the variable resistance from the potentiometer (VR1) as in Fig (2.4) , do not connect R1.
8. Set the voltage source to Voc measured in step (3) and the variable resistance to Rth measured in step (4).
9. Measure the voltage on the opened terminals of the series connection. 5.9
10. Short circuit the terminals of the series connection and measure the current in the short circuit. 3.2
11. Define the relation between the voltage values measured in steps (3,9)
12. Define the relation between the current values measured in steps (4, 10)
13. Compute the ratio between the measured voltage Voc and current Isc in steps (3,4)
14. Define the relation between the computed value in step (13) and the resistance measured in step (5)
15. Connect the resistance R1 across terminal a-b of Fig. 2.4 and measure the voltage across it?
16. Compare voltage across R1 from step (15) to its value measured in step (2) 2.1
17. What is the relation between the circuit of Fig.2.2 and the circuit of Fig.2.4 constructed in steps (7,8)? Refer to the electric variables on the port (a, b).
18. Compare the short circuit current value with the Norton current source determined by computation.



$Rth = \frac{Voc}{Is.c}$

Fig (2.3)

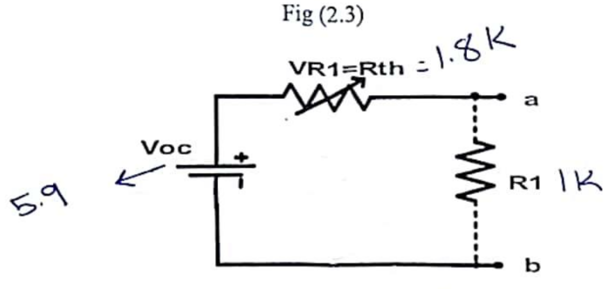


Fig (2.4)

Components List: R1=R4=1 kΩ , R5=3.3 kΩ, R6=4.7kΩ
Resistance Decade Box