Spring 2023

EEE/ETE 141L

Electrical Circuits-I Lab (Sec-19)

Faculty: Mr. Saif Ahmed (SfA)

Instructor: Md. Rabiul Karim Khan

Lab Report 06: Verification of Thevenin's, and Norton's Theorem.

Date of Performance:
09 April 2023

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30 April 2023

Group no.: 05

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Experiment Name: Verification of Thevenin's, and Norton's Theorem.

Objectives:

- Experimentally perform Thevenin's theorem, Norton theorem.
- Perform theoretical calculations.
- Verify the experimental values with theoretical values.

Apparatus:

- Breadboard
- Resistors (1× 1.0 kΩ, 1× 5.0 kΩ, 2× 10 kΩ)
- Digital Multimeter (DMM)
- DC Power Supply
- Wires

Circuit Diagram:

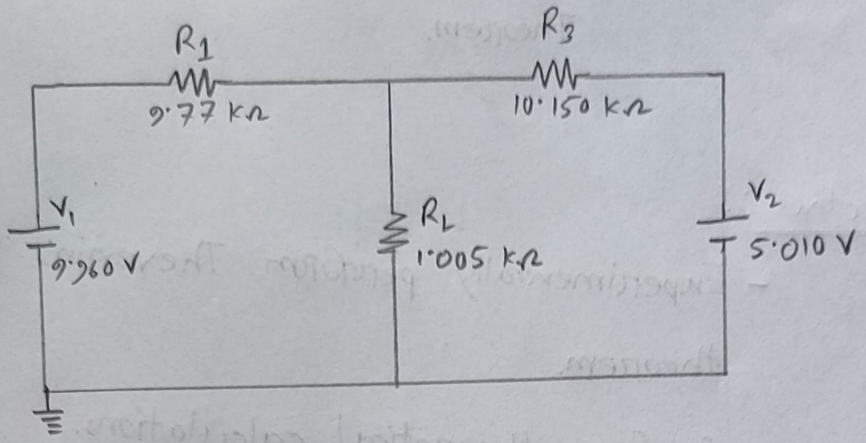


Fig.: Original Circuit

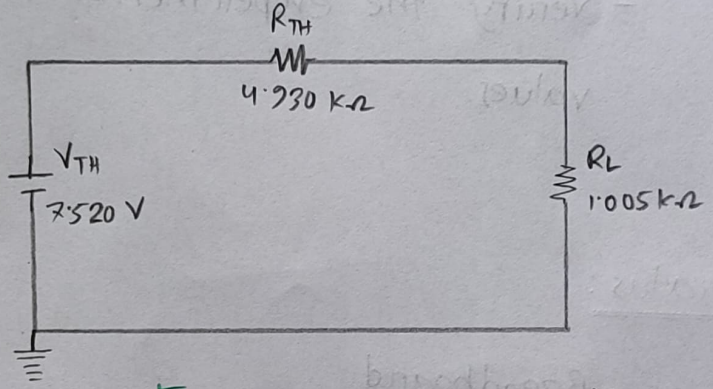


Fig.: Thevenin's Equivalent Circuit

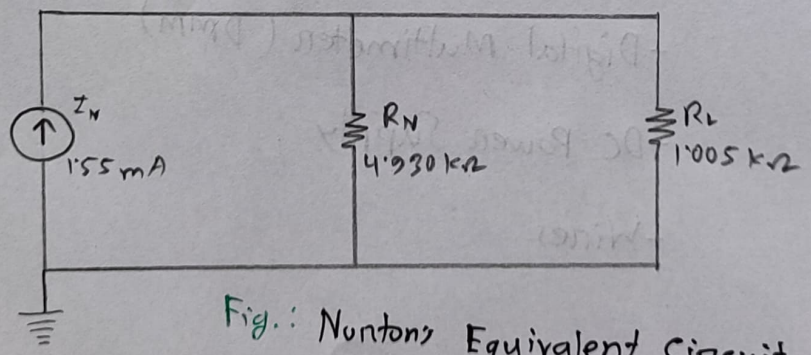


Fig.: Norton's Equivalent Circuit

Data Table & Calculation:

Table-1:

Theoretical R (kΩ)	Measured R (kΩ)	% Error
	R_1 = 9.770 kΩ R_3 = 10.150 kΩ	
R_{TH} = 4.978	R_L = 1.005 R_{TH} = 4.930	R_{TH} = 0.96 %

Table-2: Original Circuit

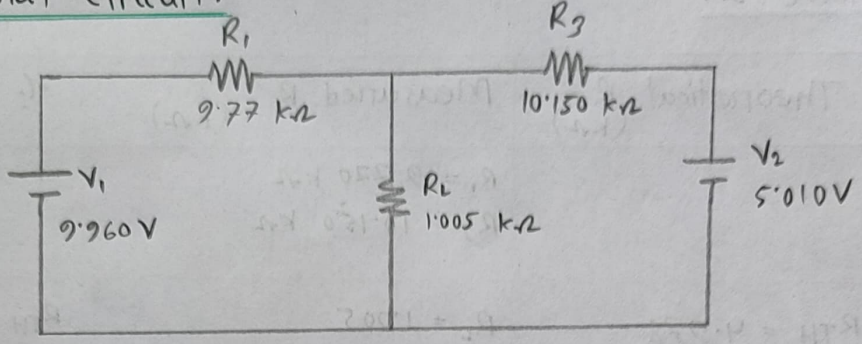
Value	Measured	Theoretical	% Error
V_L (V)	1.263	1.265	0.16 %

Table-3:

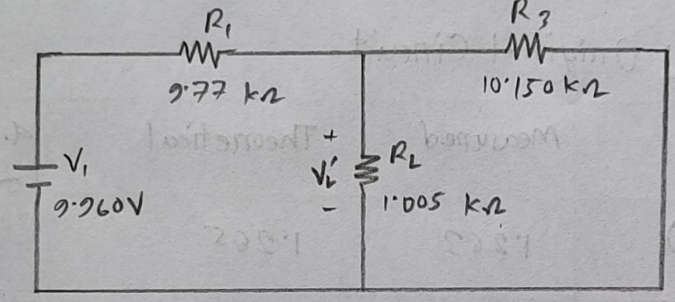
Measurement	Measured	Theoretical	% Error
V_{TH} (V)	7.520	7.532	0.16 %
I_N (mA)	1.520	1.513	0.46 %
$R_{TH} = R_N$ (kΩ)	4.980	4.978	0.04 %
V_L (V) $_{TH\text{-circuit}}$	1.274	1.273	0.08 %
I_N (mA)	1.550	1.513	2.45 %
V_L (V) $_{N\text{-circuit}}$	1.293	1.294	0.08 %

Calculation :

Original Circuit:

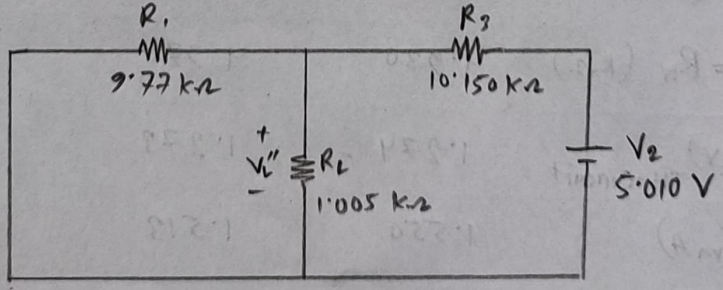


Using Super Position theorem,



$$V_L' = \frac{\left(\frac{1}{1.005} + \frac{1}{10.150}\right)^{-1}}{9.77 + \left(\frac{1}{1.005} + \frac{1}{10.150}\right)^{-1}} \times 9.960$$

$$= 0.852 \text{ V}$$



$$V_L'' = \frac{\left(\frac{1}{1.005} + \frac{1}{9.77}\right)^{-1}}{10.150 + \left(\frac{1}{1.005} + \frac{1}{9.77}\right)^{-1}} \times 5.010$$

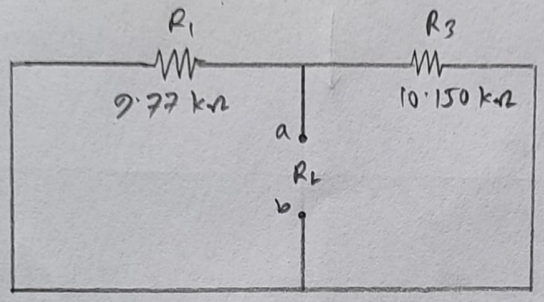
$$= 0.413 \text{ V}$$

$$\therefore V_L = V_L' + V_L''$$

$$= (0.852 + 0.413)\ V$$

$$= 1.265\ V$$

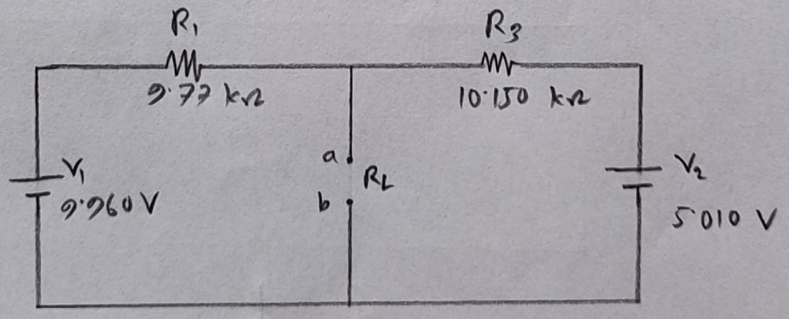
Thevenin's & Norton's Equivalent $R_{TH} = R_N$:



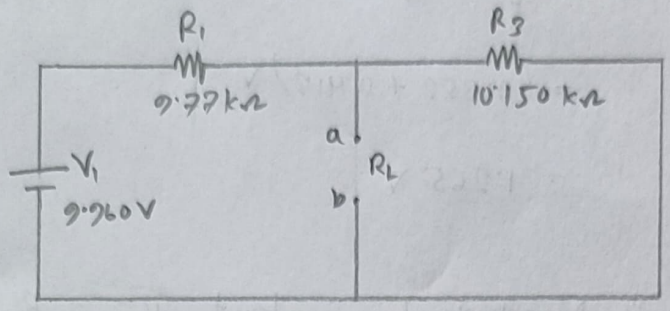
$$\therefore R_{TH} = R_N = \left(\frac{1}{9.77} + \frac{1}{10.150}\right)^{-1}$$

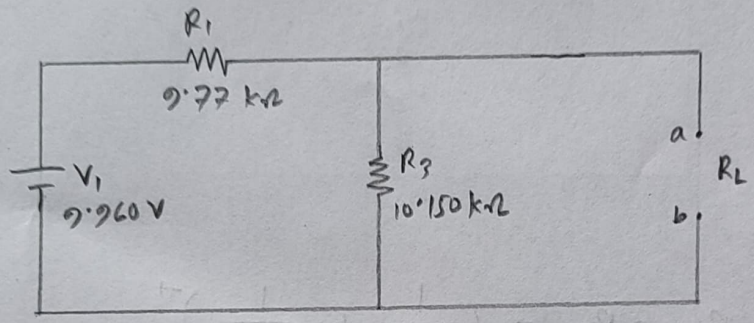
$$= 4.978\ k\Omega$$

Thevenin's equivalent voltage, V_{TH} :



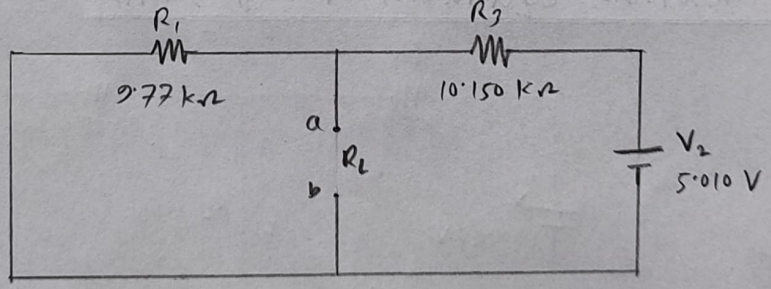
Using Super Position theorem:

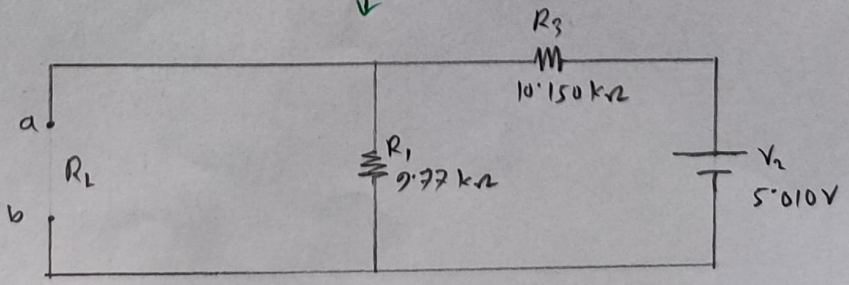




$$\therefore V_{TH}' = \frac{10{\cdot}150}{9{\cdot}77 + 10{\cdot}150} \times 9{\cdot}260$$

$$= 5{\cdot}075 \text{ V}$$





$$\therefore V_{TH}'' = \frac{9.77}{9.77 + 10.150} \times 5.010$$

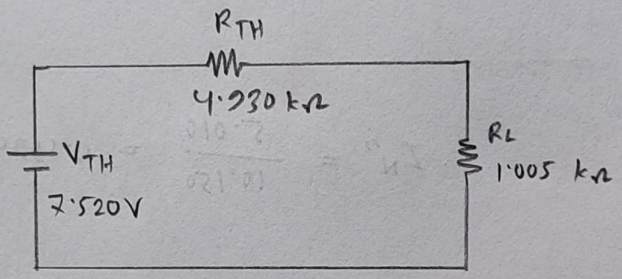
$$= 2.457 \text{ V}$$

$$\therefore V_{TH} = V_{TH}' + V_{TH}''$$

$$= 5.075 + 2.457$$

$$= 7.532 \text{ V}$$

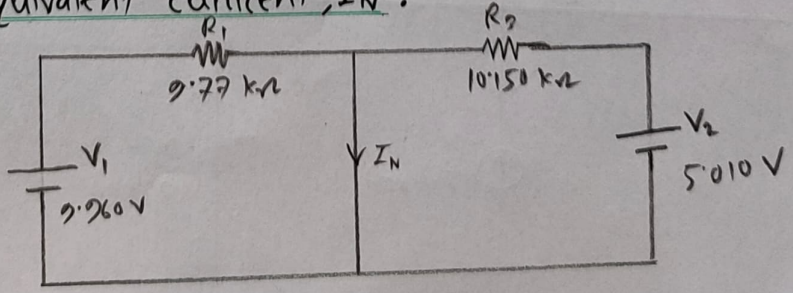
Thevenin's equivalent circuit:



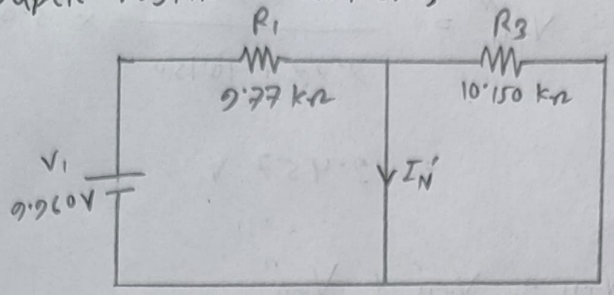
$$\therefore V_L \text{ (TH-Circuit)} = \frac{1.005}{4.930 + 1.005} \times 7.520$$

$$= 1.273 \text{ V}$$

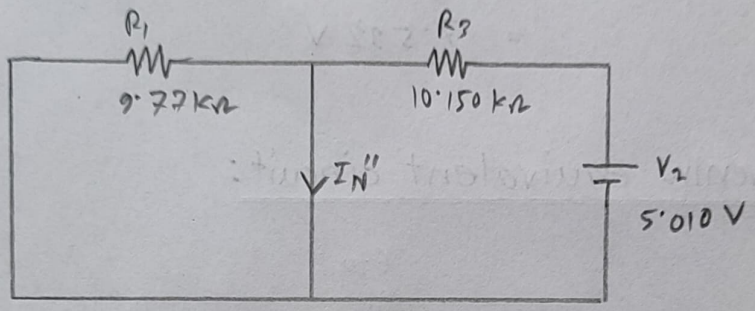
Norton's equivalent current, I_N:



Using Super Position theorem,



$$\therefore I_N' = \frac{9.960}{9.77} = 1.019 \text{ mA}$$



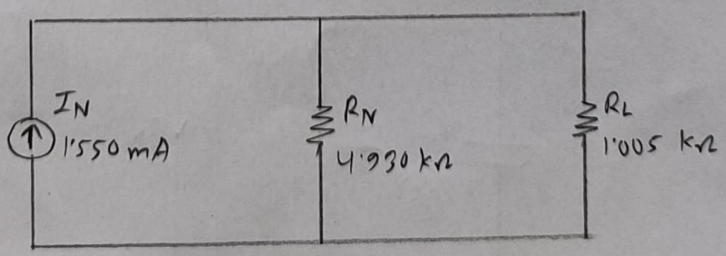
$$\therefore I_N'' = \frac{5.010}{10.150} = 0.494 \text{ mA}$$

$$\therefore I_N = I_N' + I_N''$$

$$= 1.019 + 0.494$$

$$= 1.513 \text{ mA}$$

Norton's equivalent circuit:



$$\therefore I_{R_L} = \frac{\left(\frac{1}{4.930} + \frac{1}{1.005}\right)^{-1}}{1.005} \times 1.550$$

$$= 1.288 \text{ mA}$$

$$\therefore V_L \text{ (N-circuit)} = (1.288 \times 1.005)\ V$$

$$= 1.294\ V$$

Error Calculation:

We know,

$$\text{Error} = \left| \frac{\text{Theoretical Value} - \text{Measured Value}}{\text{Theoretical Value}} \right| \times 100\%$$

$$V_{TH} = \left| \frac{7.532 - 7.520}{7.532} \right| \times 100\%$$

$$= 0.16\%$$

$$I_N = \left| \frac{1.513 - 1.520}{1.513} \right| \times 100\%$$

$$= 0.46\%$$

$$R_{TH} = \left| \frac{4.978 - 4.980}{4.978} \right| \times 100\%$$

$$= 0.04\%$$

$$V_L(TH) = \left| \frac{1.273 - 1.274}{1.273} \right| \times 100\%$$

$$= 0.08\%$$

$$I_N = \left| \frac{1.513 - 1.550}{1.513} \right| \times 100\%$$

$$= 2.45\%$$

$$V_L = \left| \frac{1.294 - 1.293}{1.294} \right| \times 100\%$$

$$= 0.08\%$$

Graph: N/A.

Result Analysis:

From the data table of this experiment, we found that the theoretical and measured values are the same. We also get that the VL of the original circuits and Thevenin's equivalent circuits, also Norton's equivalent circuits are the same.

Therefore, our circuits completely follow Thevenin's and Norton's theorem.

Questions and Answers:

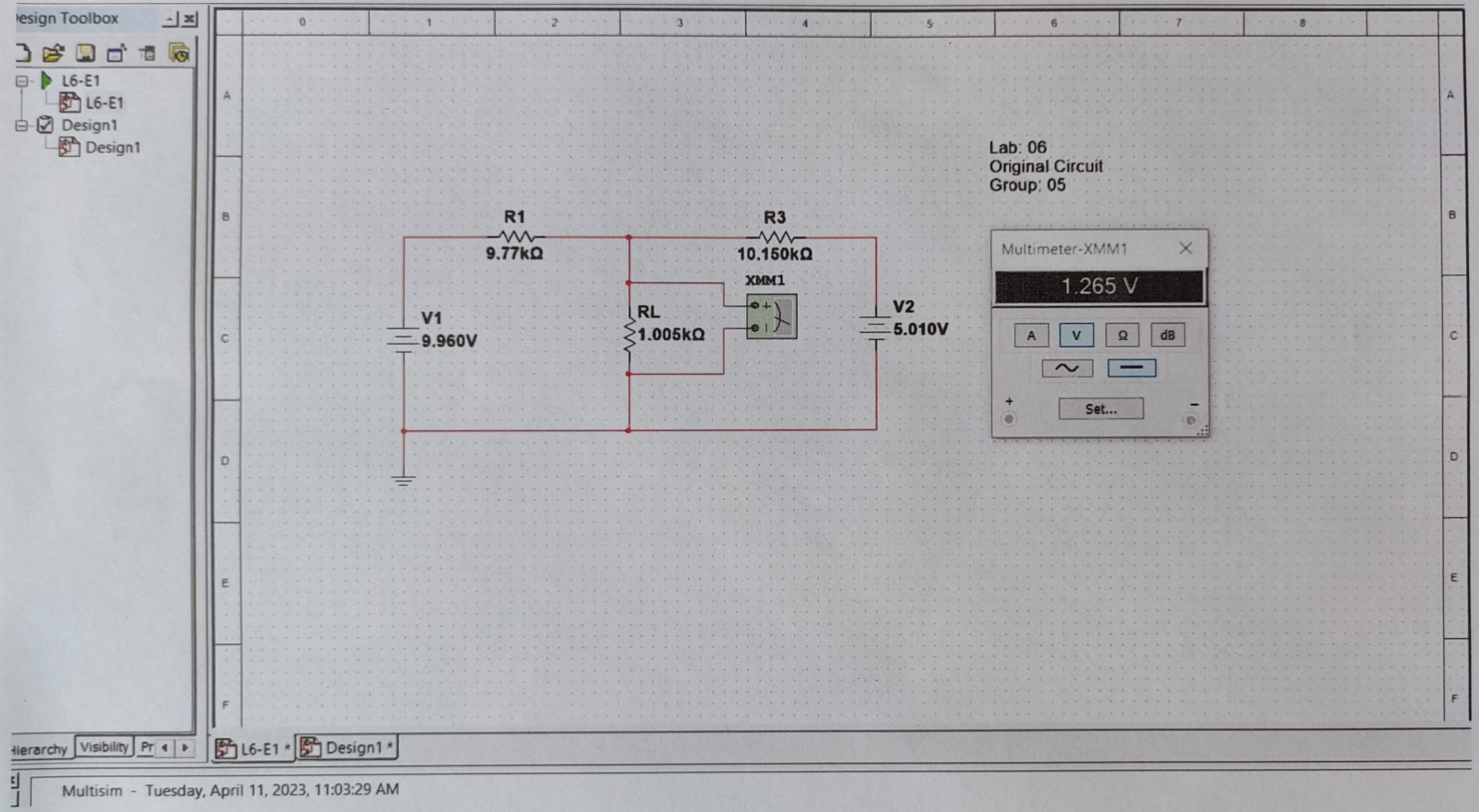
1. Already showed in Data Table section.
2. Already showed in Data Table section.

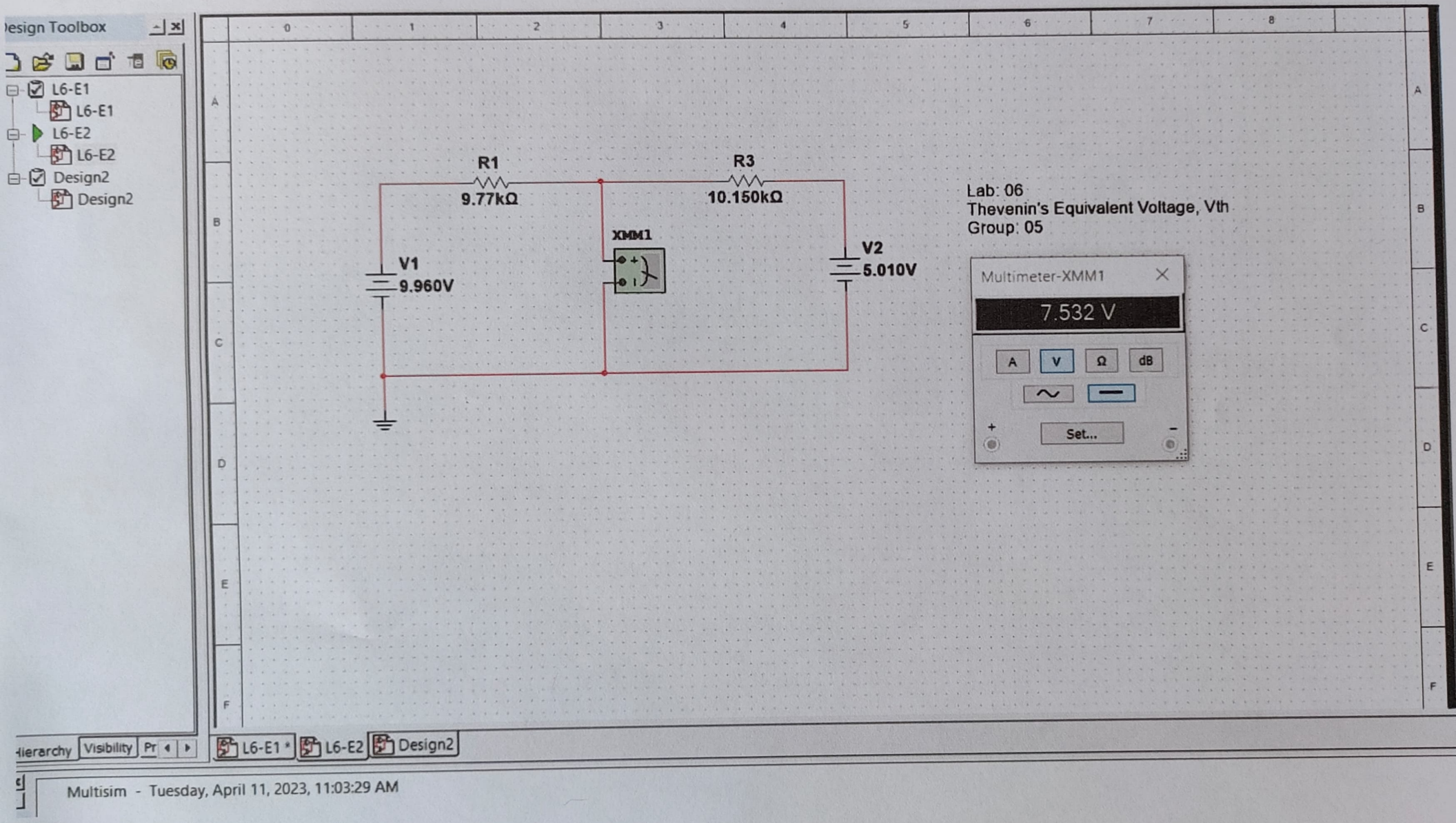
Discussion:

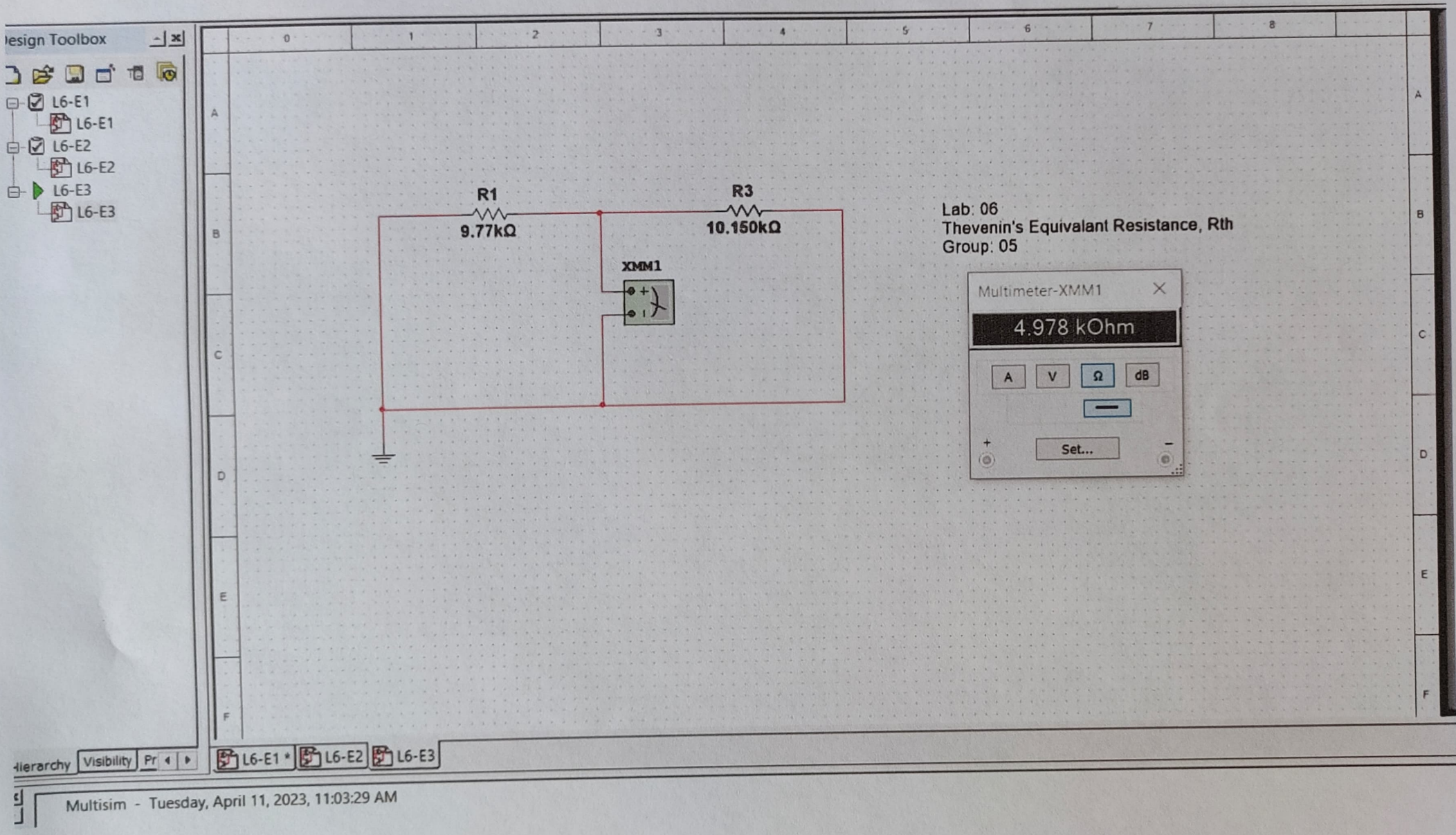
After completing this experiment, we learnt to verify Thevenin's and Norton's Theorem. Now we can convert a complex circuit into a simple circuit using these two theorems. We need to remove the load and measure the R_T and the voltage for Theven's Theorem and the current for Norton's Theorem at points a and b. In this experiment, we don't face any difficulties. We completed this experiment on time.

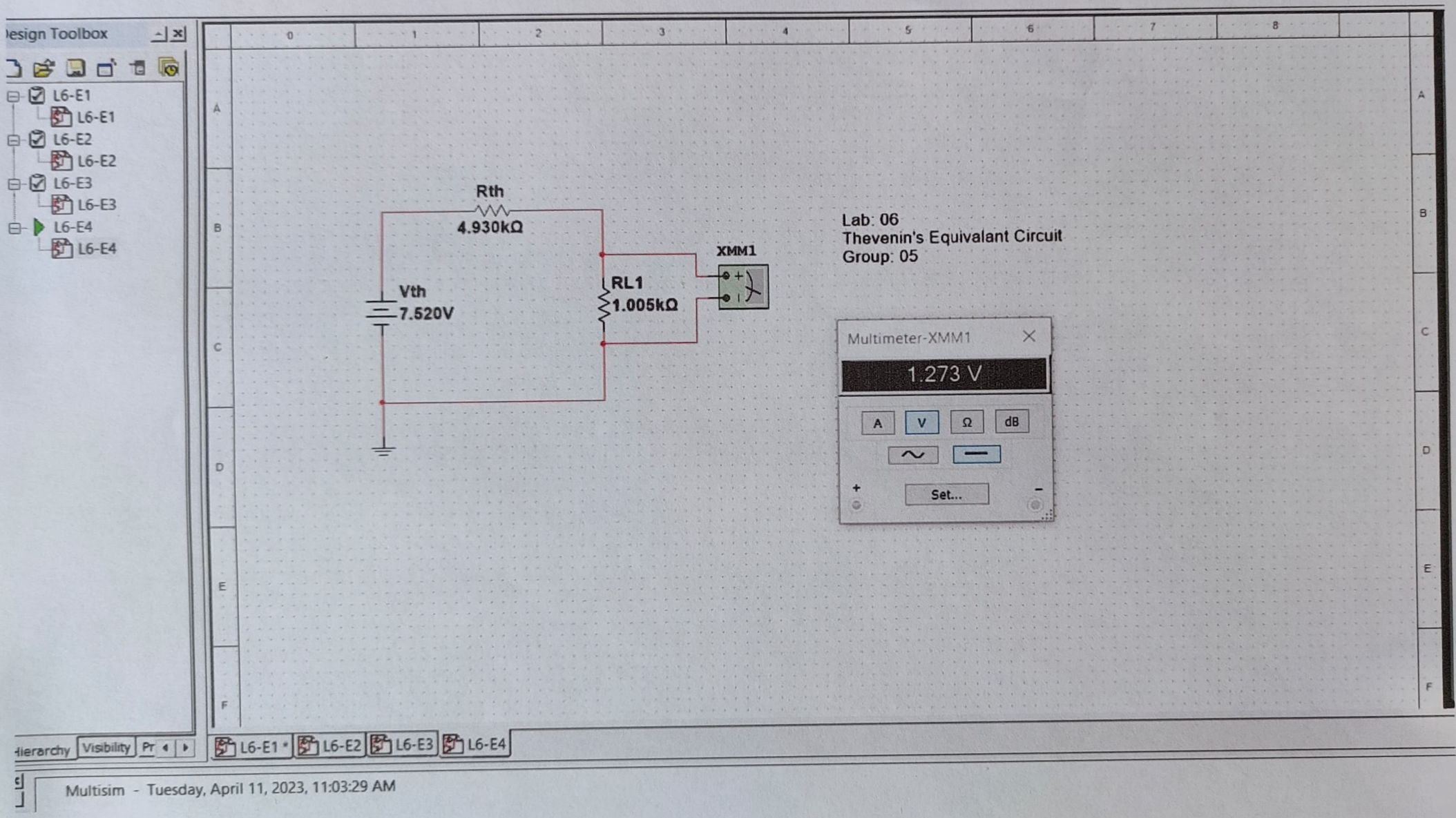
Attachment:

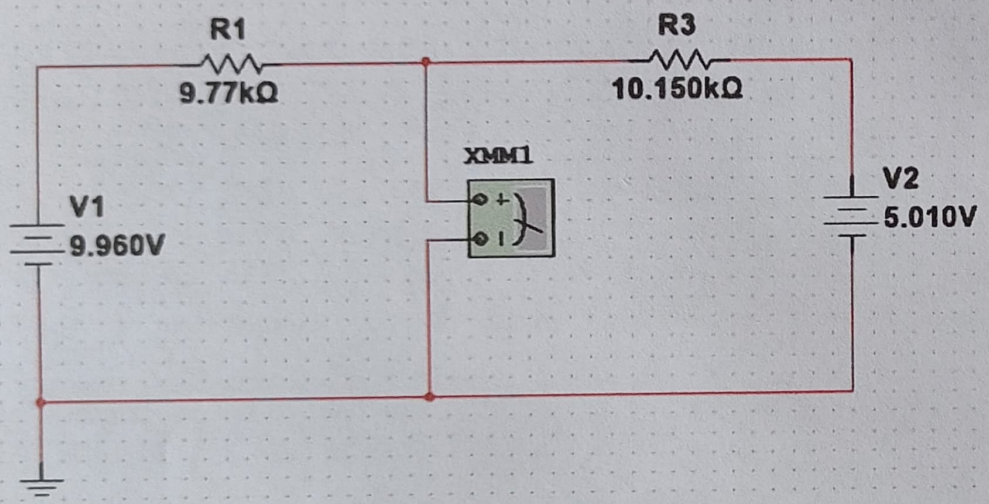
1. Signed Data Table.
2. Simulation using Multisim.


Design Toolbox
L6-E1
L6-E1
Design1
Design1
Lab: 06
Original Circuit
Group: 05
R1
9.77kΩ
R3
10.150kΩ
XMM1
V1
9.960V
RL
1.005kΩ
V2
5.010V
Multimeter-XMM1
1.265 V
A
V
Ω
dB
Set...
Hierarchy
Visibility
L6-E1 *
Design1 *
Multisim - Tuesday, April 11, 2023, 11:03:29 AM


Design Toolbox
L6-E1
L6-E1
L6-E2
L6-E2
Design2
Design2
R1
9.77kΩ
R3
10.150kΩ
XMM1
V1
9.960V
V2
5.010V
Lab: 06
Thevenin's Equivalent Voltage, Vth
Group: 05
Multimeter-XMM1
7.532 V
A
V
Ω
dB
Set...
Hierarchy
Visibility
L6-E1 *
L6-E2
Design2
Multisim - Tuesday, April 11, 2023, 11:03:29 AM

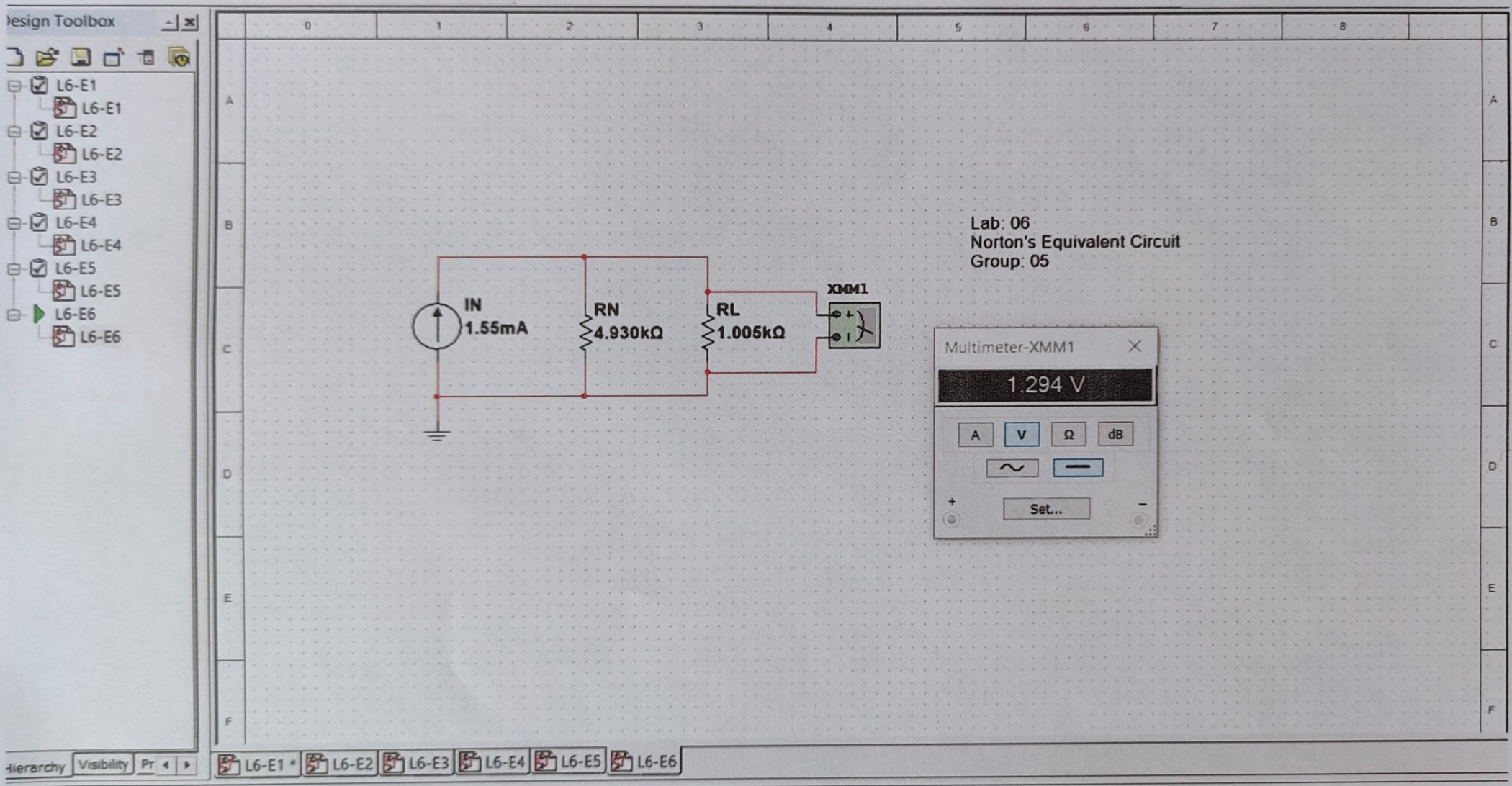

Design Toolbox
L6-E1
L6-E1
L6-E2
L6-E2
L6-E3
L6-E3
R1
9.77kΩ
R3
10.150kΩ
XMM1
Lab: 06
Thevenin's Equivalant Resistance, Rth
Group: 05
Multimeter-XMM1
4.978 kOhm
A
V
Ω
dB
Set...
Hierarchy
Visibility
L6-E1 *
L6-E2
L6-E3
Multisim - Tuesday, April 11, 2023, 11:03:29 AM


Design Toolbox
L6-E1
L6-E1
L6-E2
L6-E2
L6-E3
L6-E3
L6-E4
L6-E4
Rth
4.930kΩ
Vth
7.520V
RL1
1.005kΩ
XMM1
Lab: 06
Thevenin's Equivalant Circuit
Group: 05
Multimeter-XMM1
1.273 V
A
V
Ω
dB
Set...
Hierarchy
Visibility
L6-E1 *
L6-E2
L6-E3
L6-E4
Multisim - Tuesday, April 11, 2023, 11:03:29 AM

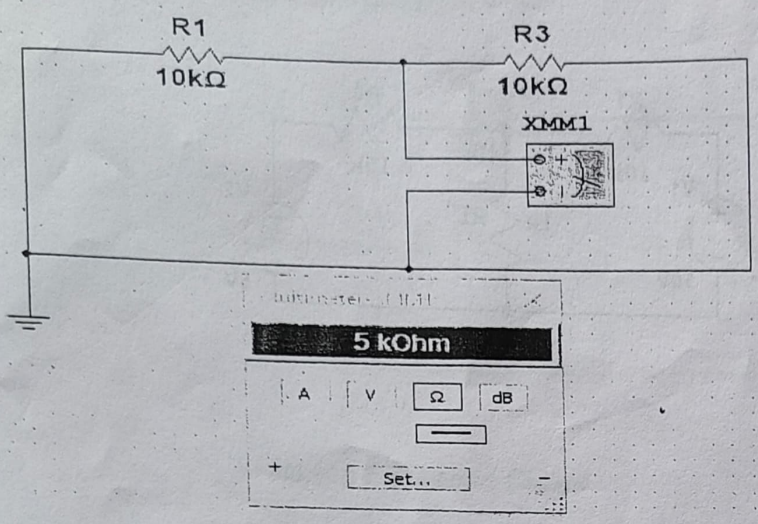


Lab: 06
Norton's Equivalant Current, In
Group: 05

L6-E1 * L6-E2 L6-E3 L6-E4 L6-E5


Design Toolbox
L6-E1
L6-E1
L6-E2
L6-E2
L6-E3
L6-E3
L6-E4
L6-E4
L6-E5
L6-E5
L6-E6
L6-E6
Lab: 06
Norton's Equivalent Circuit
Group: 05
IN
1.55mA
RN
4.930kΩ
RL
1.005kΩ
XMM1
Multimeter-XMM1
1.294 V
A
V
Ω
dB
Set...
Hierarchy
Visibility
L6-E1 *
L6-E2
L6-E3
L6-E4
L6-E5
L6-E6
Multisim - Tuesday, April 11, 2023, 11:03:29 AM

Thevenin's equivalent resistance, R_{TH}:



Data Collections:

Group No. _____
Instructor's Signature _____

Table 1:

Theoretical R	Measured R	% Error
	$R_1 = 9.77\ k\Omega$, $R_3 = 10.150\ k\Omega$	
	$R_L = 1.005\ k\Omega$, $R_{Th} = 4.930\ k\Omega$	

Table 2:

Value	Measured	% Error
V_L(V)	1.263 V	
I_L(mA)		

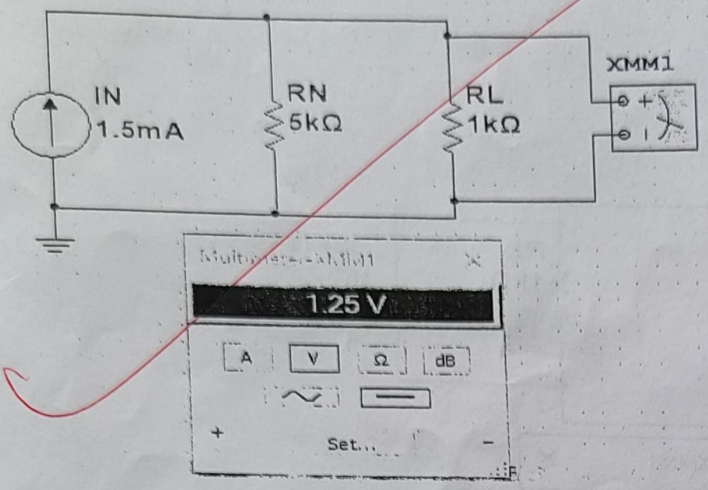
Table 3:

Measurement	Measured	Calculated	% Error
V_{TH}(V)	7.520		
I_N(mA)	1.520		
R_{TH}(KΩ)= RN (KΩ)	4.980		
V_L(V)	1.274		
I_L(mA)			

$I_{Th} = 1.55\ mA$

$V_{RL} = 1.293\ V$

Norton's equivalent circuit:



9/4/23