ELEC-2110

Electric Circuit Analysis

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LAB SECTION: 002

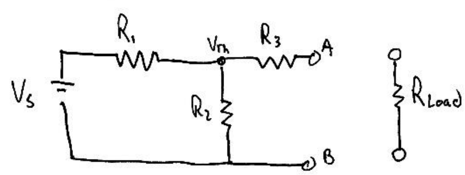
Electrical Measurements:
Thevenin Equivalent Circuits

Introduction

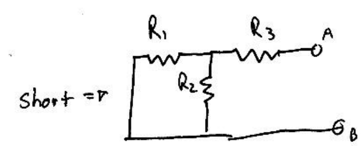
The Objective of this lab was to review and work with Thevenin's and Norton's theorems. We used black boxes with unknown circuits inside to test and confirm Thevenin's and Norton's theorems.

Exercise 1

In exercise 1, we were asked to show the mathematical derivation for how we know the voltage at two nodes will be $V_{OC}/2$ when a resistor, R_{load}, is connected to those nodes that is equal to R_{Th} [1]. Calculations shown in Calculations 1.



$$V_{Th} = \frac{V_s \times R_2}{R_1 + R_2}$$



$$R_{Th} = (R_1 \overset{\text{Parallel}}{\parallel} R_2) + R_3$$

$$R_{Th} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} + R_3$$

Calculations 1

Exercise 2

In exercise 2, we were asked to measure and record the resistance between pin_1 - pin_2 and between pin_2 – pin_3 of your variable resistor [1]. The sum of both should be close to 10 kΩ. The data is shown in Table 1 below.

Pin_1 & Pin_2	5.3345 kΩ
Pin_2 & Pin_3	4.7218 kΩ
Sum of Pins 1&2 and Pins 2&3	10.0877 kΩ

Table 1

Exercise 3

In exercise 3, we were asked to experimentally determine the Thevenin equivalent circuit for the black box at terminals B1-B2. We were told to connect the 15V supply on the NI ELVIS Board to terminals A1-A2 as shown in the schematic in Figure. Turn on the component box and [1]

- Measure the voltage of the power supply on the NI ELIVIS Board
- Measure the voltage at terminals B1 - B2, which would be V_{oc}.
- Calculate $V_{oc}/2$
- Measure the voltage drop across the variable resistor as you vary its resistance.
- Measure the variable resistor's resistance, which is R_{Th}.

Each of these steps will be repeated for each unknown circuit box, so they will be labeled accordingly below. The voltage from the Elvis board will be constant (V_s = 15.656V).

V_S	15.629 V
Voc	15.567 V
Voc/2	7.7835 V
R_{TH}	2.0007 kΩ

Box 1 Measured Data

V_{oc}	5.2065 V
$V_{oc}/2$	2.60325 V
R_{Th}	5.3168 kΩ

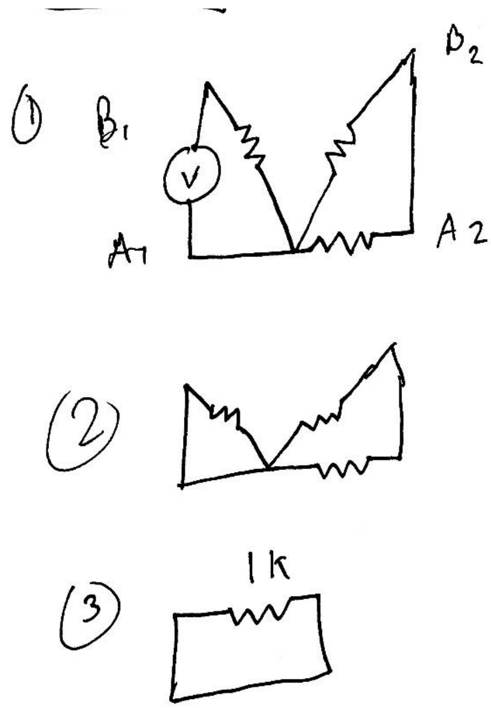
Box 2 Measured Data

V_{oc}	-3.1250
$V_{oc}/2$	-1.5625
R_{Th}	1.1974

Box 3 Measured Data

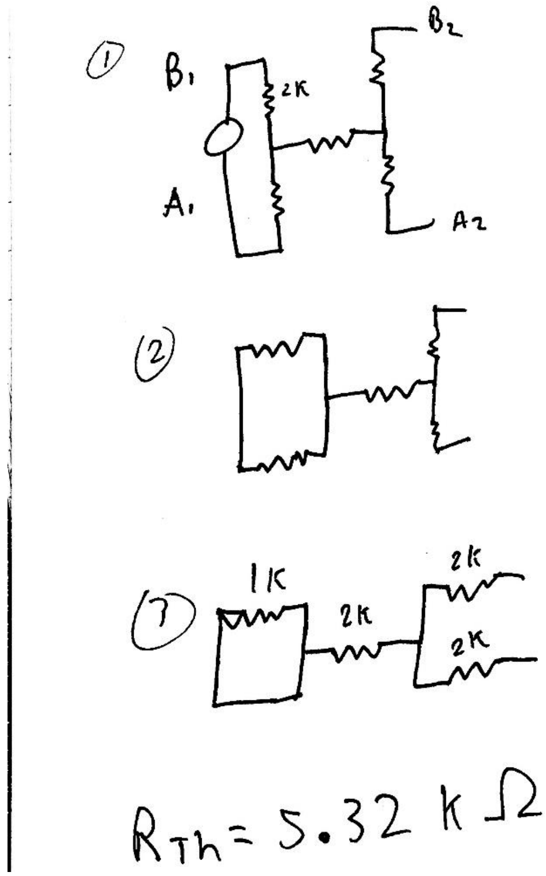
Exercise 4

In exercise 4, we were asked to open the boxes of unknown circuits, draw the circuits with Thevenin and Norton equivalent. We then used the equivalent circuits to calculate [1]. Each circuit is labeled for the appropriate box. (*Note that each resistor is 2kΩ and V_s is 15.656 V*)

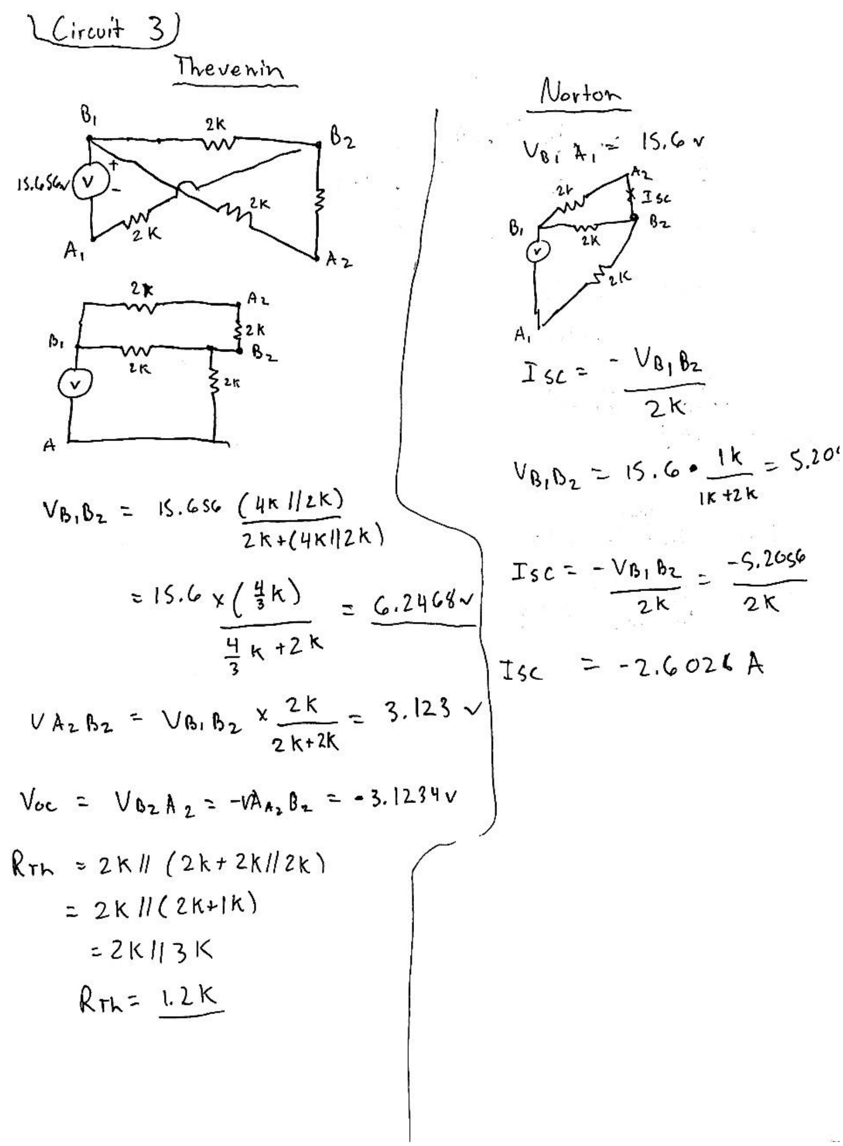


$R_{Th} = 1k\Omega$

Circuit and Rth for Box 1



Circuit and Rth for Box 2



Circuit, I_{SC} and Rth for Box 3

Exercise 5

In exercise 5, we were asked knowing what we do about this specific black box, is it possible to measure the Thevenin resistance at B1-B2 directly from the black box?

The answer is yes, we are able to measure R_{Th} directly when we short circuit terminals a1 and b1.

Conclusion

This lab was used as an overview of Thevenin's and Norton's theorem. We were given circuits and asked to calculate various things using Thevenin equations and then verify it through Multisim. I did have some struggles with this lab. The TA helped explain some things before we started so the lab was clearer.

Bibliography

[1] Nelms, R. Mark, and Elizabeth Devore. *Recitation & MultiSim: Thevenin's and Norton's Theorems*. 2016, p. 5, Accessed 12 Feb 2020.