Electric Circuits & Electronics Design Lab

EE 316-01

Lab 1: Circuits Review

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Lab Section 316-01

Lab Date: 6/1/22

Lab Due: 6/8/22

Introduction:

The purpose of this lab is to review key concepts of circuit theory which will be used throughout the lab and probably the semester. We will be looking at Ohm's law, Kirchhoff's voltage and current laws, and Norton and Thevenin equivalents using theoretical analysis, simulations, and experiments. This report will have 5 main sections. First is the theoretical analysis which would normally be done as the pre-lab along with the Multisim simulations. Then we have the physical circuits which are constructed on breadboards in lab. Afterwards, we compare the results from those 3 sections and conclude with an analysis of the results.

Theoretical Analysis:

Simulations:

Experimental:

For the last portion of the lab, we did the same things as prior but on a physical board to validate the conceptual results we obtained. We started with the same circuit from Figure 1, however, we only performed the analysis once, using only nominal values for components. The results can be seen in Table 8 of the results portion of this lab. Voltages were measured with a multi-meter placed on both ends of a resistor and currents were measured by removing one end of a resistor and attaching it to one multi-meter and placing the other multi-meter lead at the point where the resistor was previously attached.

Next we built the circuit from Figure 4 on the breadboard and repeated the measurements from Multisim. The results can be seen in Table 9 of the results portion of this lab.

The final experimental step in this lab was creating a Thevenin equivalent for the circuit given in Figure 2. We first built the circuit on the breadboard and used the multi-meter to measure the open circuit voltage and short circuit current. Those values are given below.

V_{oc} = 2.5

I_{sc} = 1.65mA

R_{th} = 1.512K Ω

Using these values, we were able to construct a Thevenin equivalent circuit using a 2.5-volt source and a 1.512K Ohm resistor in series with it. This circuit gave us the same open circuit voltage and short circuit current as the original circuit, but with only two components needed instead of four. We did not attempt to construct a Norton equivalent on the physical boards.

Results and Discussion:

The first two tables have the data previously discussed in the last portion of this lab. The values found here match closely with both the theoretical values and the simulated values in some cases and in others differ greatly. The smaller discrepancies can be explained by tolerances in the parts used experimentally and on the multi-meter. The huge discrepancies are probably from not obtaining the reading in the correct way.

Table 8: Simulated Values at Nominal

Branch Node or Loop #	Branch Voltages (V)	Branch Currents (mA)	Node Voltages (V)	Loop Currents (mA)
1	0.36	3.627	4.7	3.627
2	0.273	25.51	4.6	1.69
3	88.42 mv	0.93	4.4	0.93
4	92.8 mv	0.93	3.6	
5	0.740	0.002		
6	4.4	2.12		
7	3.6	1.69		

Table 9: Breadboard Data

RL	VL	IL A
10	0.48	0.044
20	0.87	0.040
40	1.47	0.035
70	2.1	0.029
100	2.56	0.024
150	3.06	0.019
200	3.40	0.016
300	3.81	0.011
500	4.23	0.008
1000	4.61	0.005

The results of this lab confirm several key circuits concepts those being: Ohm’s Law, Kirchhoff’s Voltage and Current Laws, and Thevenin and Norton equivalent circuits.

Ohm's Law which is V=I*R can be seen in the analysis on the circuit given in Figure 5. Ohms law simply says the relationship between voltage and current is linear. When we plot the results from the simulation (as we have done in Figure 9), we see that the slope of this line is -103.77, meaning that as current increases voltage decreases. The y-intercept is 5.056 and the x-intercept is 0.005.

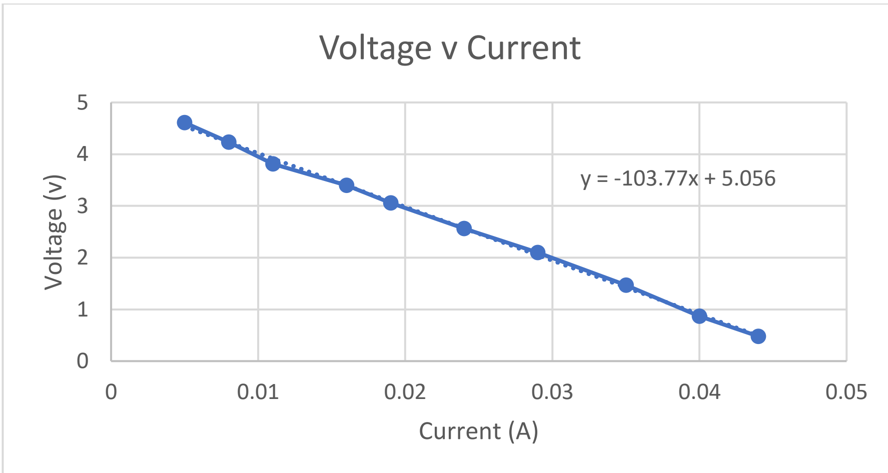


Figure 9: Voltage v. Current

Kirchhoff's Voltage Law states that the sum of the voltages around any closed loop in a circuit must be zero. Our analysis of the circuit in Figure 1 confirms this. If we look at any closed loop in that circuit, we can sum the voltages and they come out to be zero plus or minus a small margin of error.

Kirchhoff's Current Law states that the sum of currents entering and exiting any given node in a circuit must equal zero. Again, looking at Figure 1, we can sum the currents entering any given node and see that they all come out to be zero.

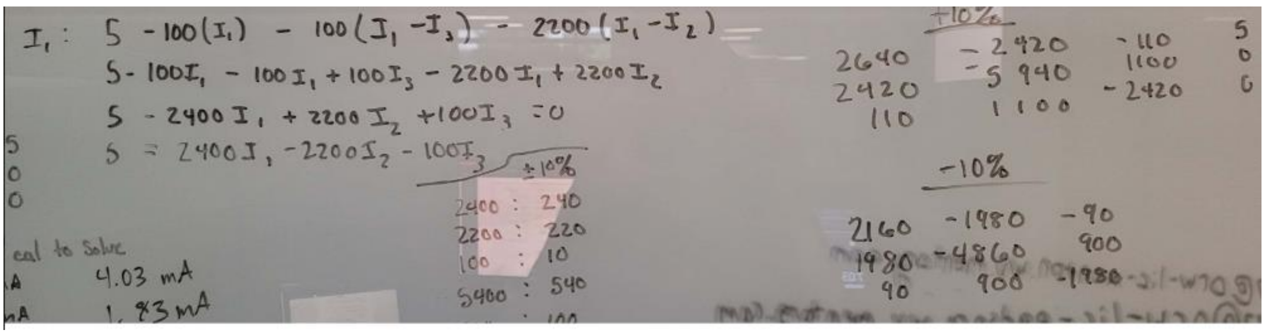
When looking at the Thevenin and Norton equivalent circuits we found that the circuits shared open circuit voltage and short circuit current as their more complex counterparts that they were emulating. Thus, using an equivalent circuit allows for easier analysis while still having the same functionality.

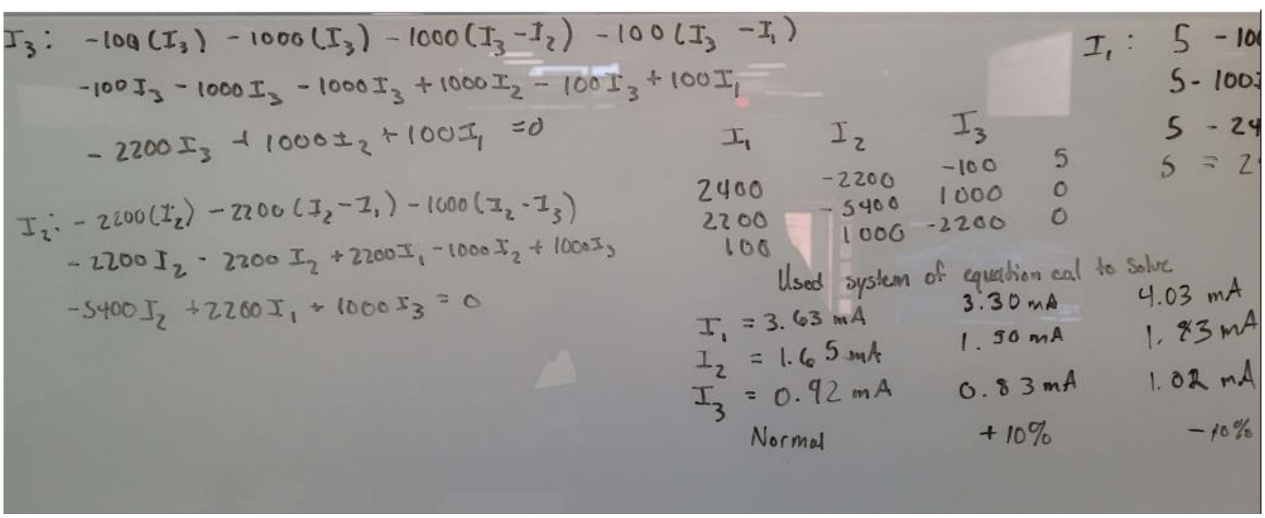
Conclusion:

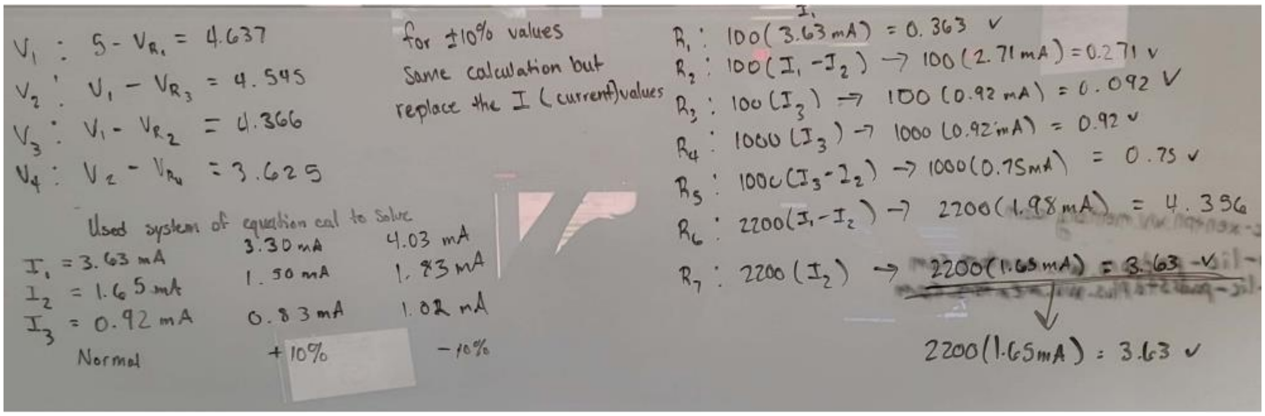
Overall, the results of the lab were closely in line with our expectations. There were only small discrepancies between the theoretical, simulation, and experimental results besides those due to human error. The circuit concepts we were trying to prove were verified by the results of the lab. This lab also provides a useful introduction to the software, lab tools, and how to properly measure what you're looking for using said lab tools which will be used throughout the semester.

Appendix 1:

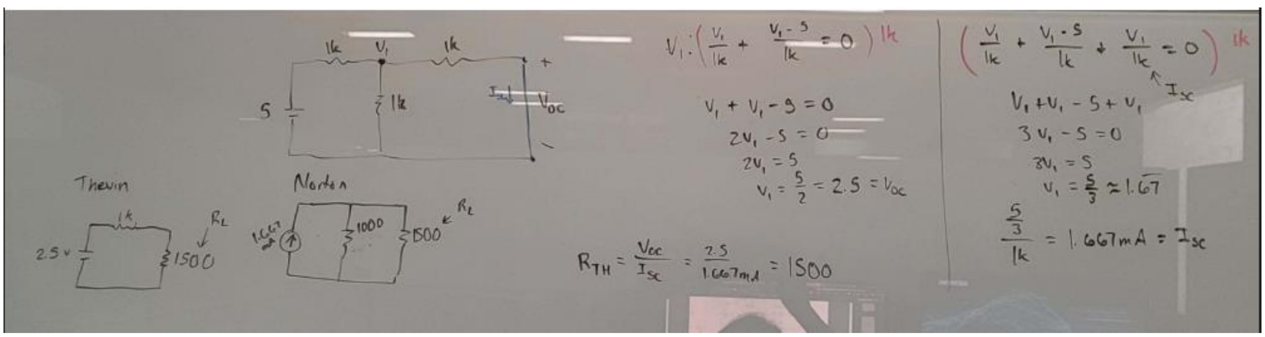
Handwritten work for Figure 1

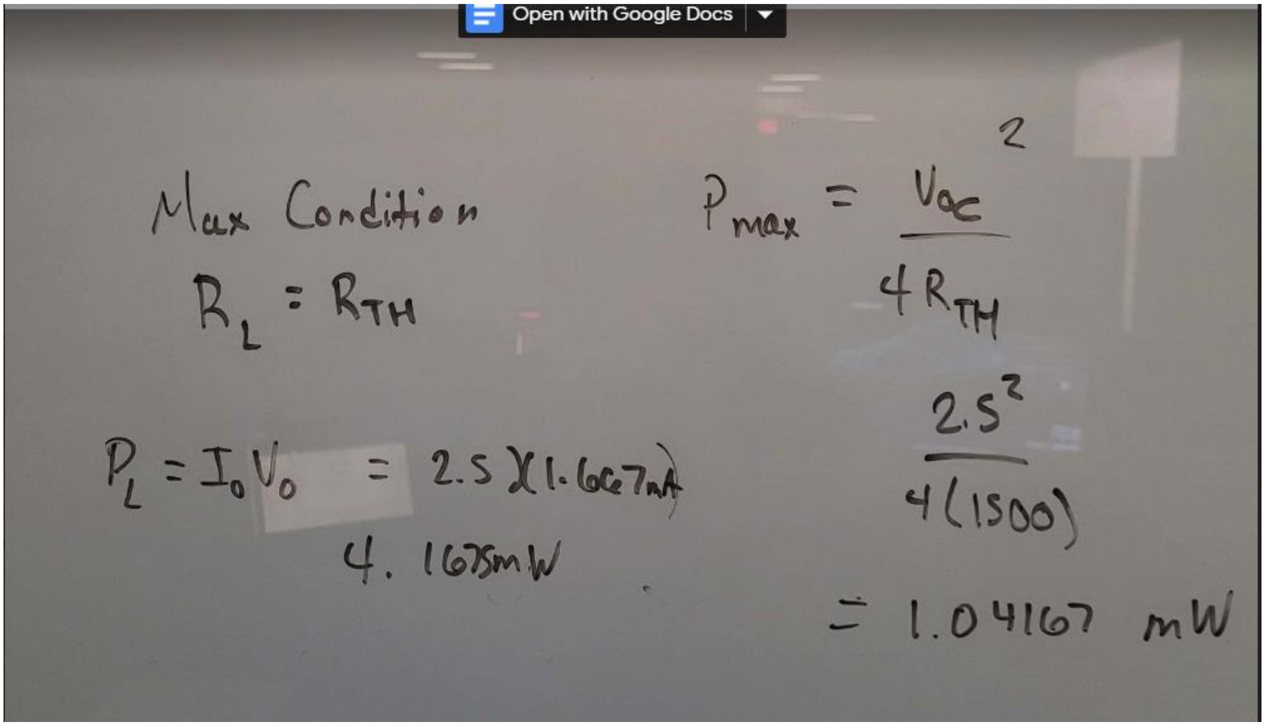






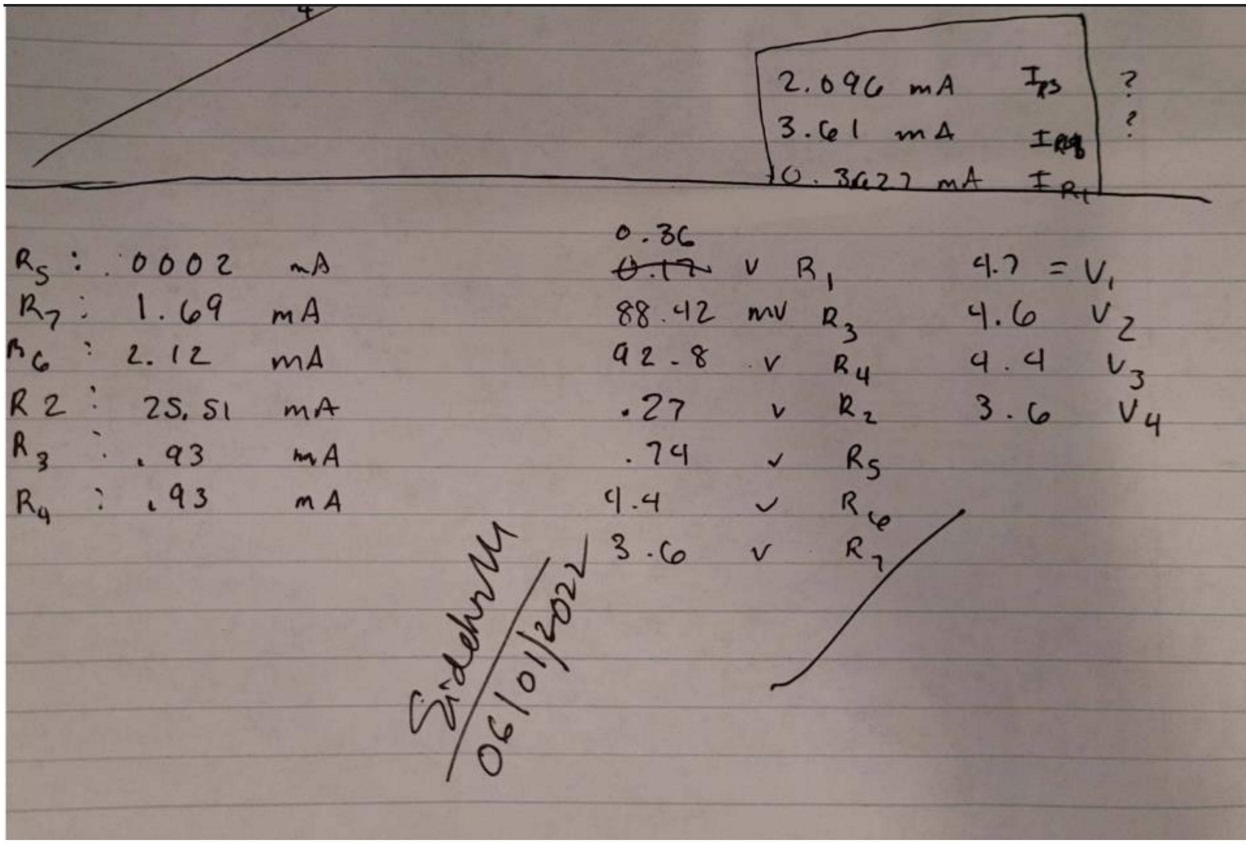
Handwritten work for Thevenin and Norton section





Appendix 2:

Signed lab results


2.096 mA I_{R3} ?
3.61 mA I_{R8} ?
0.3627 mA I_{R1}

R_5 : .0002 mA
R_7 : 1.69 mA
R_6 : 2.12 mA
R 2 : 25.51 mA
R_3 : .93 mA
R_4 : .93 mA

0.36 ~~0.17~~ v R_1
88.42 mV R_3
92.8 v R_4
.27 v R_2
.74 v R_5
4.4 v R_6
3.6 v R_7

4.7 = V_1
4.6 V_2
4.4 V_3
3.6 V_4

06/01/2022

Figure 1’s Physical Board readings

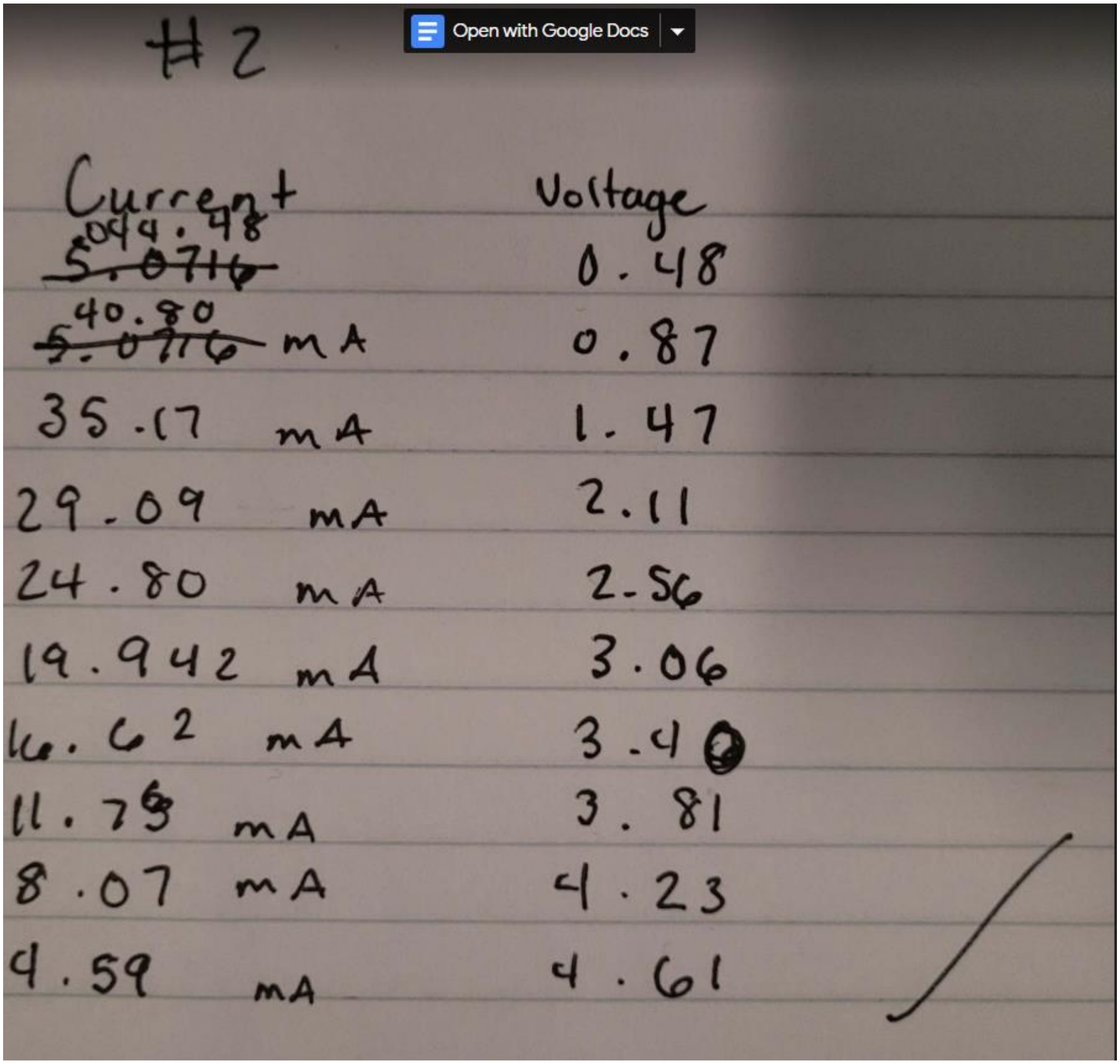
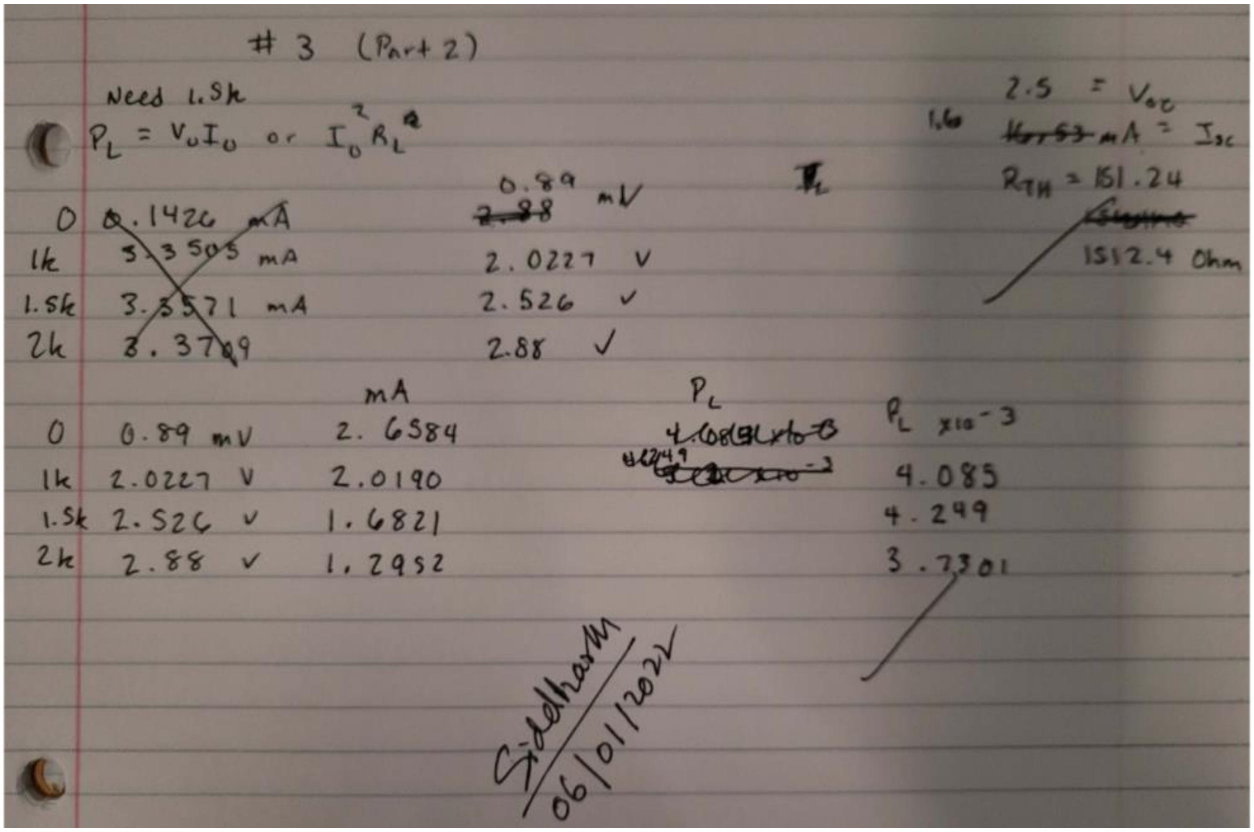


Figure 4’s Physical board results


3 (Part 2)

Need 1.5k

$P_L = V_o I_o$ or $I_o^2 R_L$

0	~~0.1426 mA~~	0.89 mV
1k	~~3.3505 mA~~	2.0227 V
1.5k	~~3.3571 mA~~	2.526 V
2k	~~3.3709~~	2.88 V

2.5 = V_{oc}

1.6 mA = I_{sc}

R_{TH} = 151.24

1512.4 Ohm

		mA	P_L $\times 10^{-3}$
0	0.89 mV	2.6584	
1k	2.0227 V	2.0190	4.085
1.5k	2.526 V	1.6821	4.249
2k	2.88 V	1.2952	3.7301

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Thevenin and Norton Physical Board results

Pictures of Circuits

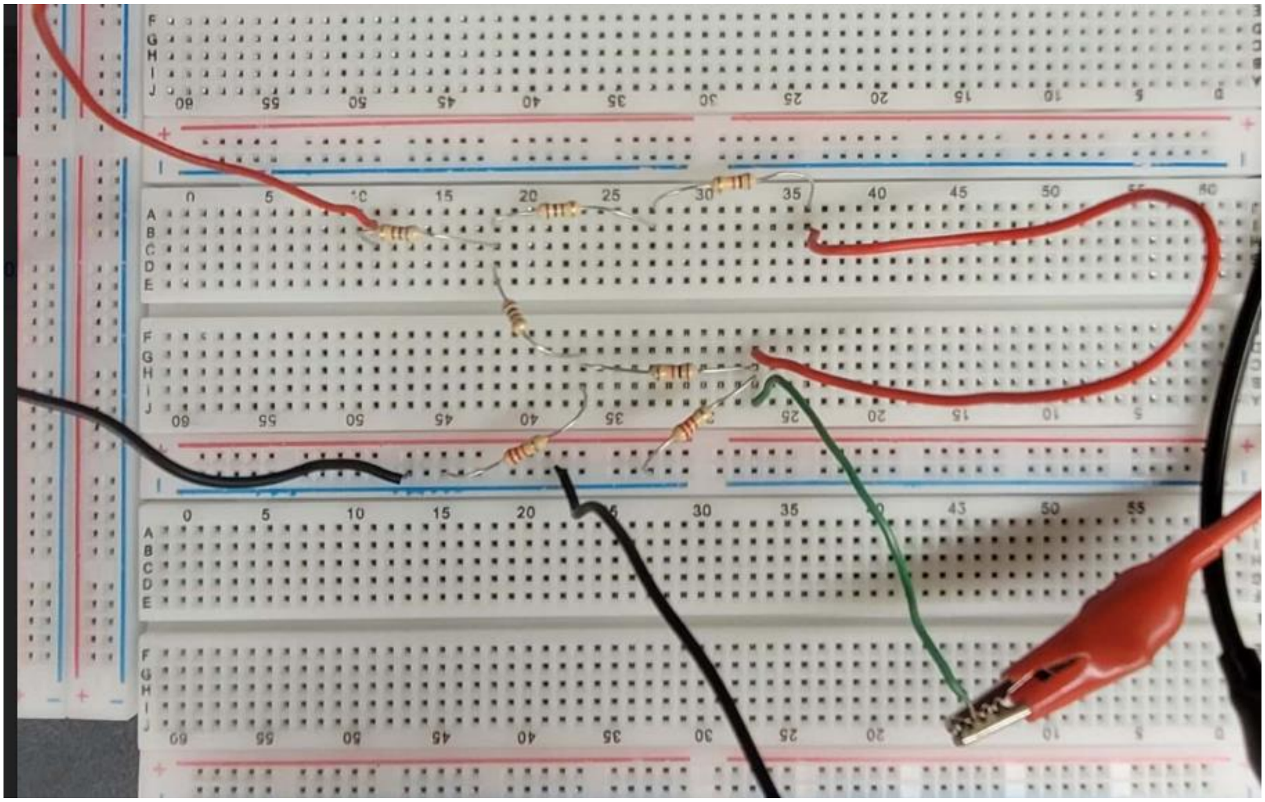


Figure 1 physical circuit

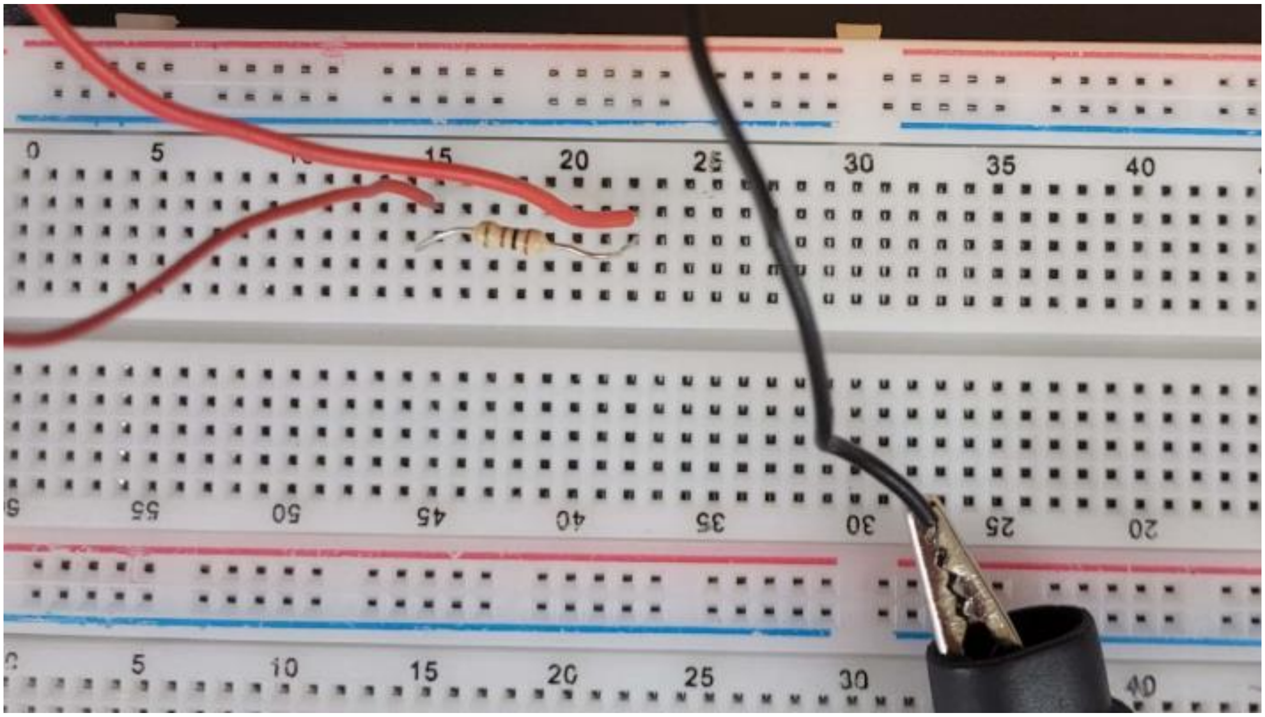
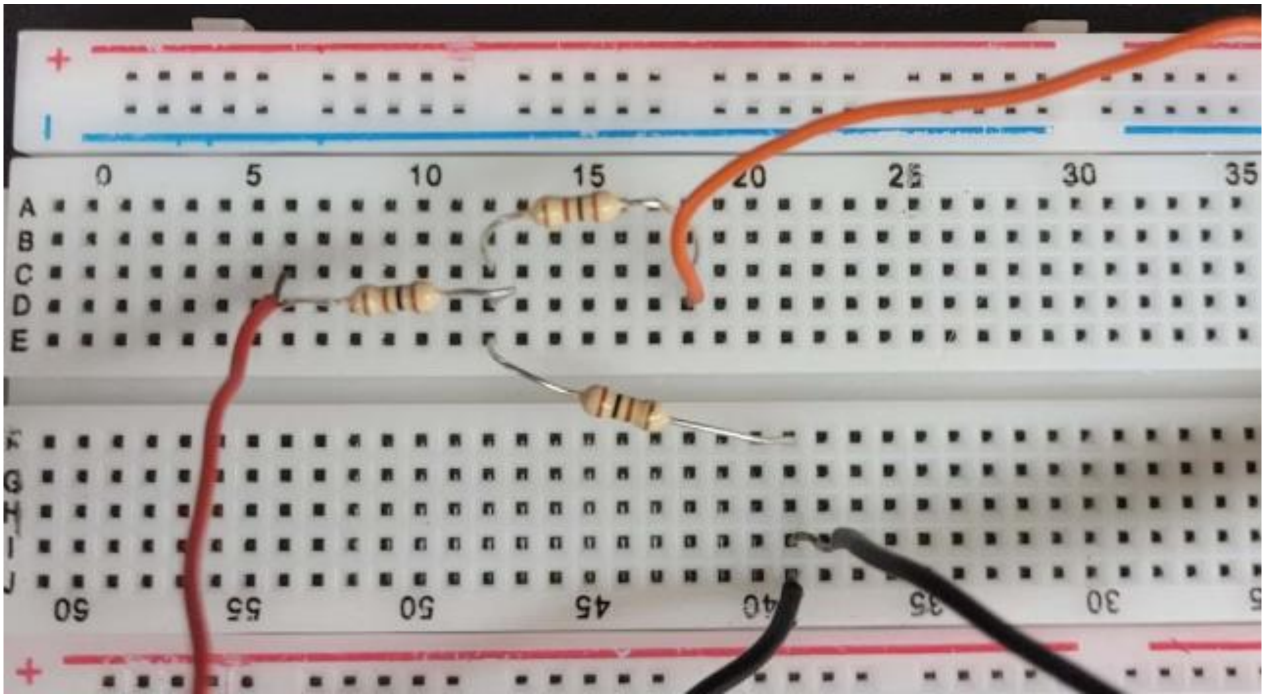


Figure 4 physical circuit



Thevenin and Norton Physical circuit used to get values