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Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

ELE 202
Electric Circuit Analysis
LAB COVER PAGE for Part II submission.

Lab #:	3	Lab Title:	Resistive Network Analysis methods Nodal and mesh

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Student #*:	501112545
Signature:	

(* Note: remove the first 4 digits from your student ID)

Section #:	22
Submission date and time:	March 5, 2022 2:20pm
Due date and time:	March 5, 2022 4:00pm

Document submission for Part II:

- A completed and signed "COVER PAGE – **Part II**" has to be included with your submission, a copy of which is available on D2L. The report will not be graded if the signed cover page is not included.
- Scan your completed pages of **Section 5.0** and **Section 6.0** (via a scanner or phone images), together with any required In-Lab Oscilloscope screen-shot images.
- Collate and create a .pdf or .docx file of the above, and upload it via D2L **by 11.59 p.m. on the same day** your lab is scheduled. *Late submissions will not be graded.*

By signing above, you attest that you have contributed to this submission and confirm that all work you have contributed to this submission is your own work. Any suspicion of copying or plagiarism in this work <u>will result in an investigation of Academic Misconduct and may result in a "0" on the work,</u> an "F" in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: www.ryerson.ca/senate/current/pol60.pdf.

5.0 IN-LAB Experiment: IMPEMENTATION & MEASUREMENTS

(a) *Circuit Reference Node*

1. Implement the circuit in **Figure 2.0a** on your breadboard using the resistor values as shown. Set the input D.C. source, E = **15V** on the power-supply and select node "d" as a *reference* node to which "COM" terminal of the DMM in the Voltmeter setting is connected to allow for direct measurement of the *unreferenced* voltage nodes.

2. With the "-" (or the reference) terminal of the DMM Voltmeter connected to the selected reference node, directly measure the voltages at nodes "a", "b", "c" and "d" (i.e. $\mathbf{V_a}$, $\mathbf{V_b}$, $\mathbf{V_c}$ and $\mathbf{V_d}$, respectively). Use the DMM Voltmeter to directly measure the voltage across resistors, $\mathbf{R_1}$ (=$\mathbf{V_{ab}}$), $\mathbf{R_2}$ (=$\mathbf{V_{bc}}$) and $\mathbf{R_3}$ (=$\mathbf{V_{cd}}$). Measure the current, **I** using the DMM set up as an Ammeter. From the above measured node voltages ($\mathbf{V_a}$, $\mathbf{V_b}$, $\mathbf{V_c}$ and $\mathbf{V_d}$), calculate the voltages $\mathbf{V_{ab}}$, $\mathbf{V_{bc}}$ and $\mathbf{V_{cd}}$. Record all your results in the below **Table 4.0**.

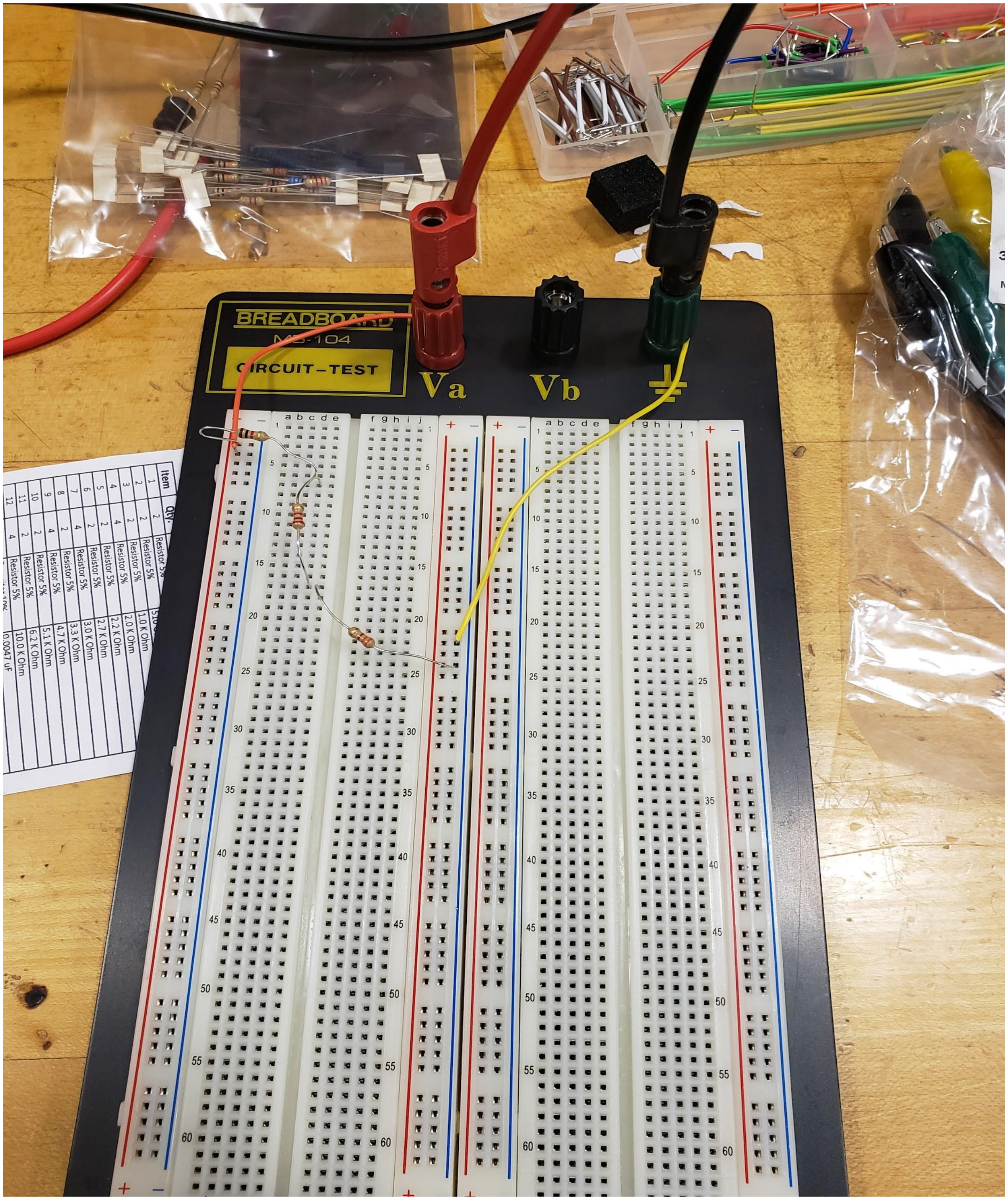
3. **Relocate** the circuit reference ground at node "c" shown in **Figure 2.0b**. Repeat **steps 1** and **2** above.

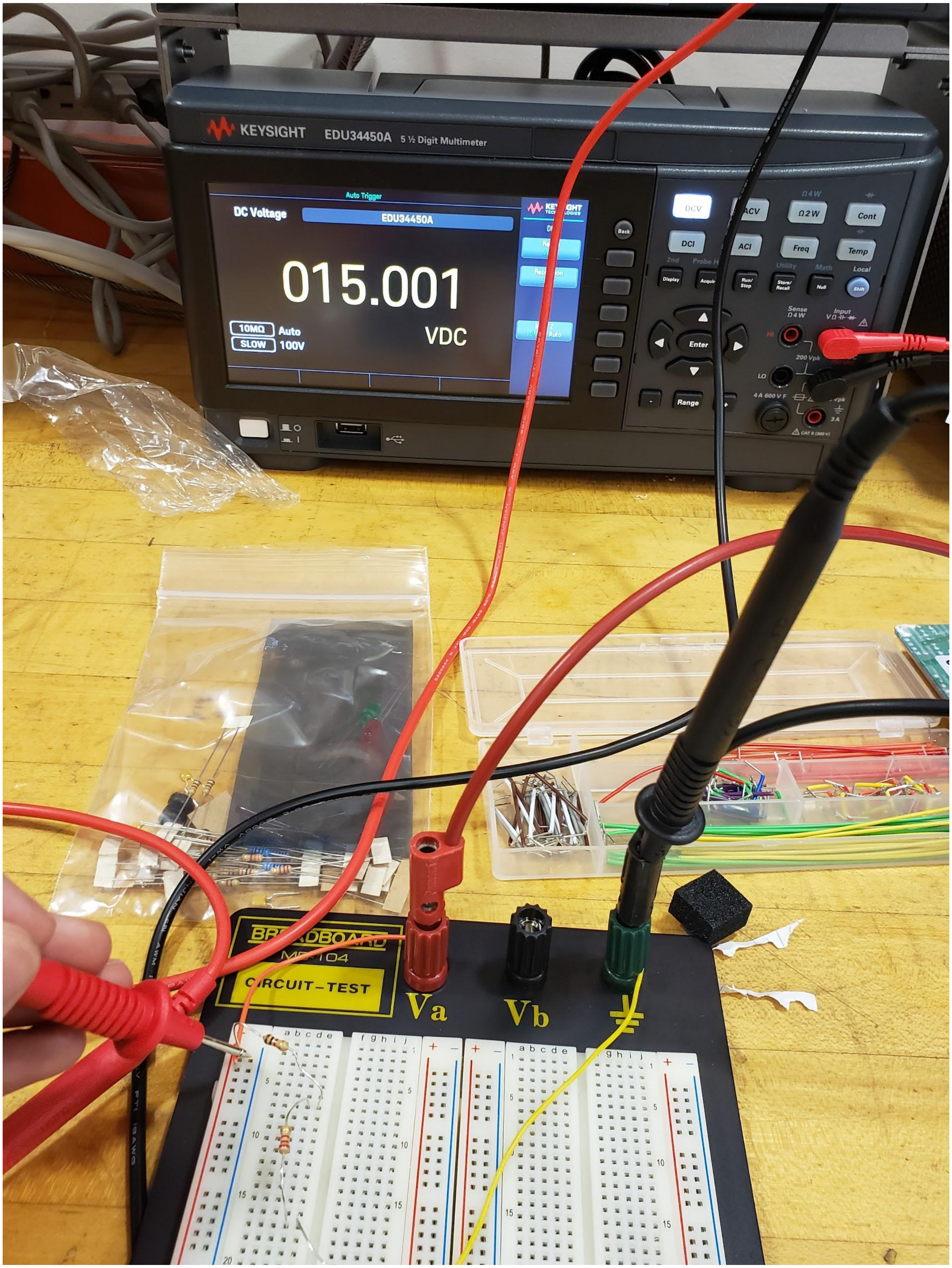
4. Turn OFF the Power Supply.

		Using *Reference* Node "d"	Using *Reference* Node "c"
I (mA)	Measured value =>	2.363	2.363
$\mathbf{V_a}$ (Volts)	Measured value =>	15.00	7.401
$\mathbf{V_b}$ (Volts)	Measured value =>	12.67	5.067
$\mathbf{V_c}$ (Volts)	Measured value =>	7.597	0
$\mathbf{V_d}$ (Volts)	Measured value =>	0	-7.579
$\mathbf{V_{ab}}$ (Volts)	Measured value =>	2.334	2.336
	Calculated value =>	2.308	2.308
$\mathbf{V_{bc}}$ (Volts)	Measured value =>	5.0665	5.0665
	Calculated value =>	5.077	5.077
$\mathbf{V_{cd}}$ (Volts)	Measured value =>	7.597	7.597
	MultiSIM value =>	7.615	7.615

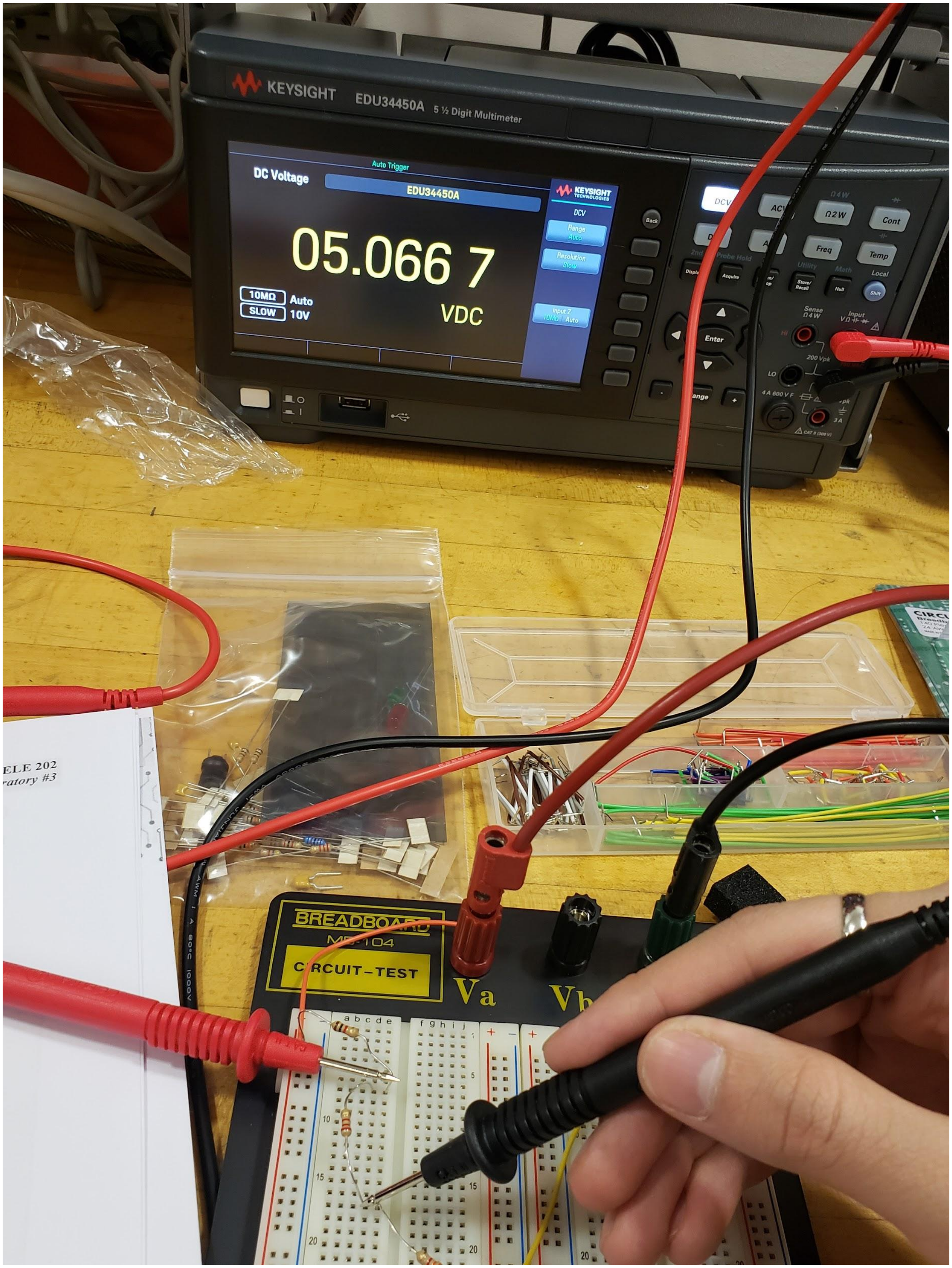
Table 4.0: Experimental results of the Figure 2.0 circuits

Pictures of the circuit from figure 2.0 at reference nodes d and c:





KEYSIGHT
EDU34450A
5 ½ Digit Multimeter
DC Voltage
Auto Trigger
EDU34450A
015.001
VDC
10MΩ
Auto
SLOW
100V
DCV
ACV
Ω2W
Cont
DCI
ACI
Freq
Temp
Enter
Range
BREADBOARD
CIRCUIT-TEST
Va
Vb


KEYSIGHT
EDU34450A 5 ½ Digit Multimeter
DC Voltage
Auto Trigger
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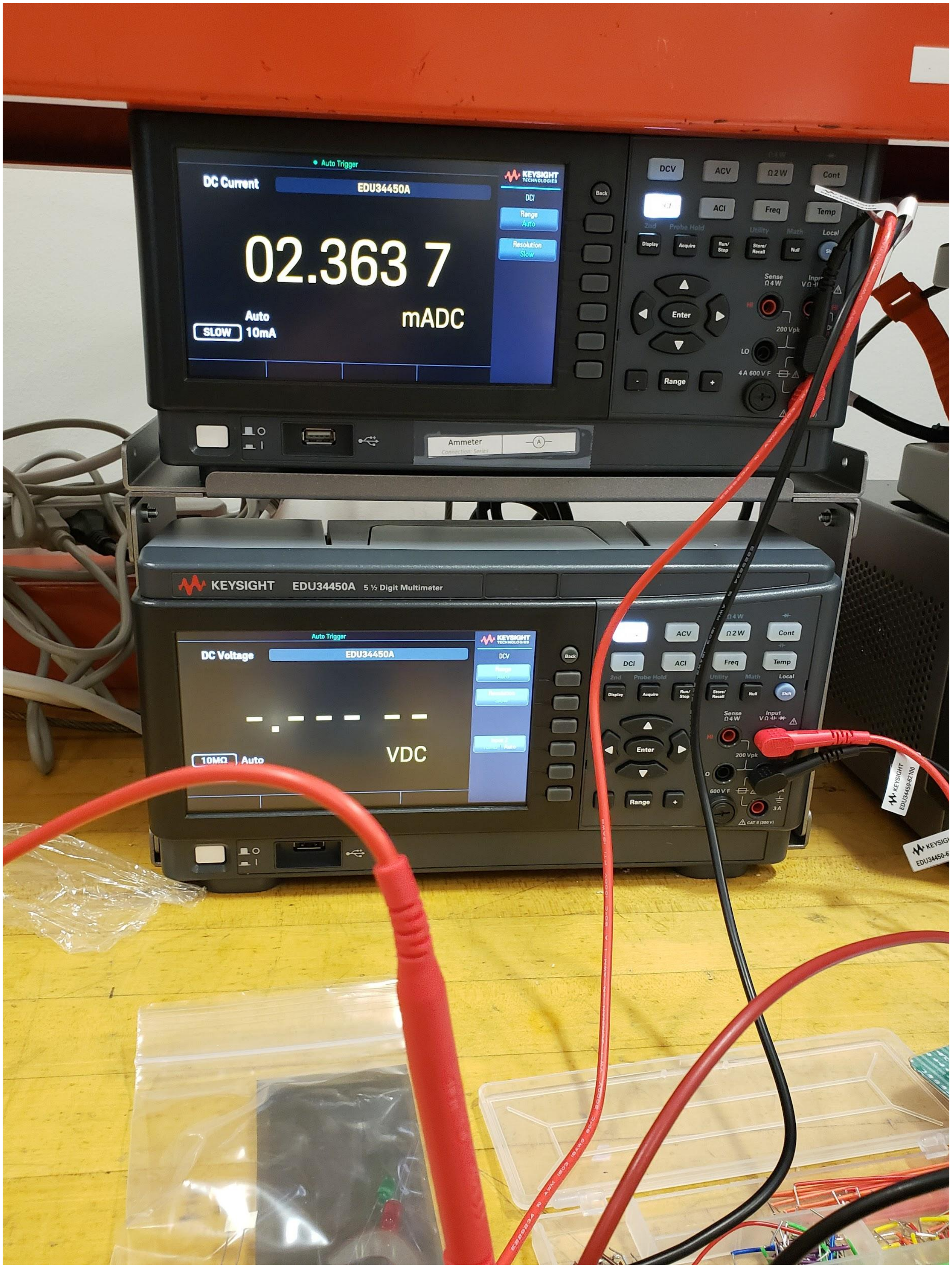
DC Current
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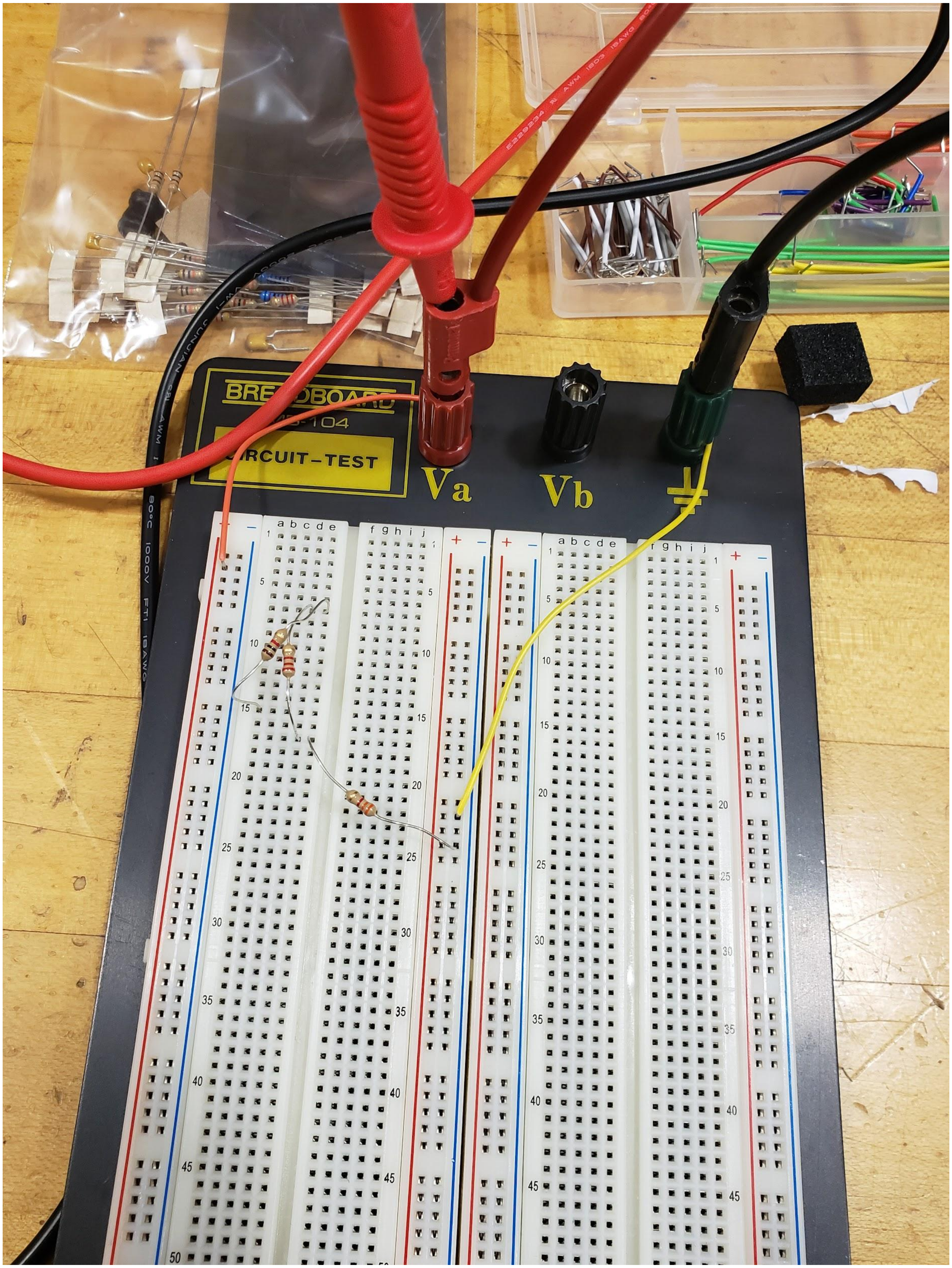
BREADBOARD
CIRCUIT-TEST
Va
Vb

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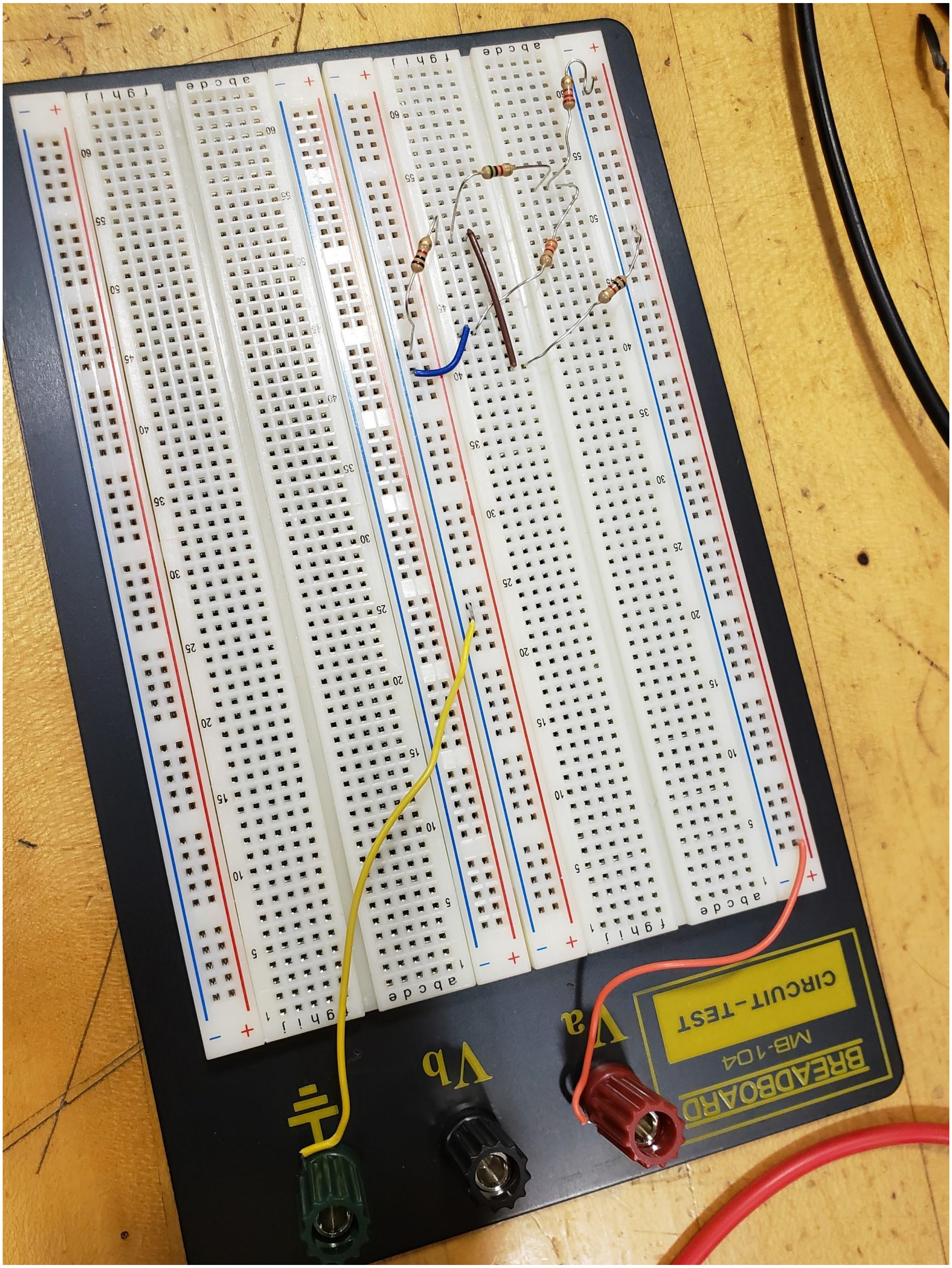
(b) *Nodal and Mesh Analysis*

1. Implement the circuit in **Figure 3.0** on your breadboard using the resistor values as shown. Set the input D.C. source, **E** = **15V** on the power-supply.
2. ***Nodal Analysis***: Refer to the circuit of **Figure 3.0a**. Use node "**d**" as the ground *reference* node, and measure the node voltages $\mathbf{V_a}$, $\mathbf{V_b}$ and $\mathbf{V_c}$ with respect to this reference ground. Then measure the branch voltage, V_X across resistor, $\mathbf{R_3}$ and the branch current, I_X through resistor, $\mathbf{R_2}$.
3. ***Mesh Analysis***: Measure the branch currents I_1, I_2, I_3 and I_X, and then use these measured branch currents to determine the values of the mesh currents, $\mathbf{I_A}$, $\mathbf{I_B}$ and $\mathbf{I_C}$ and the branch voltage, V_X. Record all your results in below **Table 5.0**.
4. Turn OFF the Power Supply

		Nodal Analysis	*Mesh* Analysis
V_a (Volts)	Measured value =>	15.001	
V_b (Volts)	Measured value =>	8.667	
V_c (Volts)	Measured value =>	7.60	
I_A (mA)	Calculated value =>		10.2
I_B (mA)	Calculated value =>		7.60
I_C (mA)	Calculated value =>		7.39
I_X (mA)	Measured value =>	2.64	2.64
V_X (Volts)	Measured value =>	7.62	7.62
I_1 (mA)	Measured value =>		2.849
I_2 (mA)	Measured value =>		0.216
I_3 (mA)	Measured value =>		7.39

Table 5.0: Experimental results of the Figure 3.0 circuits

Picture of the circuit from figure 3.0:



6.0 POST-LAB: OBSERVATIONS AND ANALYSIS OF RESULTS

1. From observing the results in **Table 4.0** of "*Circuit Reference Node*" experiment for both cases (when *reference point* at "d" and *reference point* at "c"): -

   a. State clearly which one of the currents, node voltages, or resistor voltages have changed or remain unchanged, and explain why. How do these experimental results compare to your Pre-Lab results in **Table 2.0**?

   b. Which of the two *reference points* would be your preferred choice? Explain.

   c. List, and comment on, the possible causes for any discrepancies from what you would expect theoretically or from the simulations?

workspace

a) All of the node voltages have changed due to the change in the reference point. The node voltages were dependent on the reference point so when changes occured for it, the node voltages changed. For the current and resistor voltages, they stayed the same. Current didn't change as it was dependent on the source and the voltage across the resistor didnt change as it was dependent on the current which didnt change. In terms of the results table 2.0 and 4.0 were about the same just had minor difference between values.

b) I would say reference node "d" as my preferred choice as it was the easiest to calculate for as being close to the power source.

c) Possible causes for any discrepancies could be because of the tolerance of the wires used in the experiment and or the quality of the equipment. It could also be due to human error such as hands shaking.

2. For the "***Nodal and Mesh Analysis***" experiment, compare your results in **Table 5.0** with the theoretical values and MultiSIM simulation measurements in **Table 3.0**, and explain.

   a. Specifically, did the *Nodal* and *Mesh* analysis methods yield the same results for the branch current, I_x and the branch voltage, V_x? Why?

   b. Do your results in **Table 3.0** and **Table 5.0** verify the *Nodal* and *Mesh* analysis techniques? Explain.

   c. List, and comment on, the possible causes for any discrepancies from what you would expect theoretically or from the simulations?

workspace

a) yes the Nodal and mesh analysis methods yield the same results because the same set of values were being calculated in the circuit just using two different methods.

b) Yes both table 3.0 and table 5.0 verify the nodal and mesh analysis techniques. Even being different techniques still gave the same set of calculated values.

c) Possible cause of any discrepancies would be the same as mentioned in the previous page such as the quality of the equipment tolerance in the wires and forms of human error.