CPE 316: Electrical Circuits and Electronic Design Laboratory.

Lab 01

Circuits Review (KCL, KVL, OHM'S LAW, THEVENIN & NORTON).

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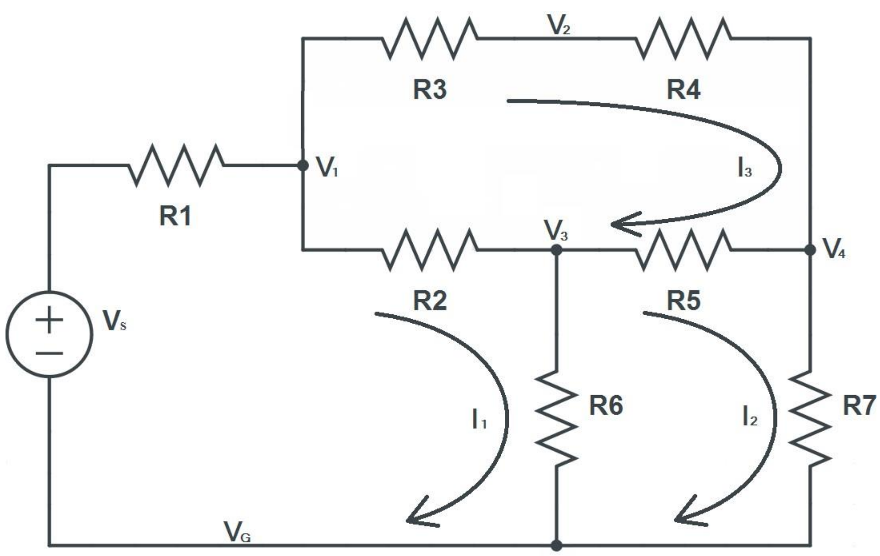
Date of Experiment: 08/22/22.

INTRODUCTION:

This laboratory session involved setting up and analyzing different circuits to verify and understand concepts like Ohm's law, Kirchhoff's Current Law, Kirchhoff's Voltage Law, and both Norton and Thevenin circuits. This lab contained two parts where we worked with both digital circuit builders and manually designed simple circuits using a breadboard, wires, voltmeters and other relevant lab equipment.

PART A:

The first task in the lab was to digitally design the circuit provided in the figure below and calculate the branch voltages, branch currents, Node voltages and loop currents. The assumption provided was that all resistors were exact, whole figures.



In addition to the assumptions, the following values were provided to start off:

$V_S = 5.0$ V.

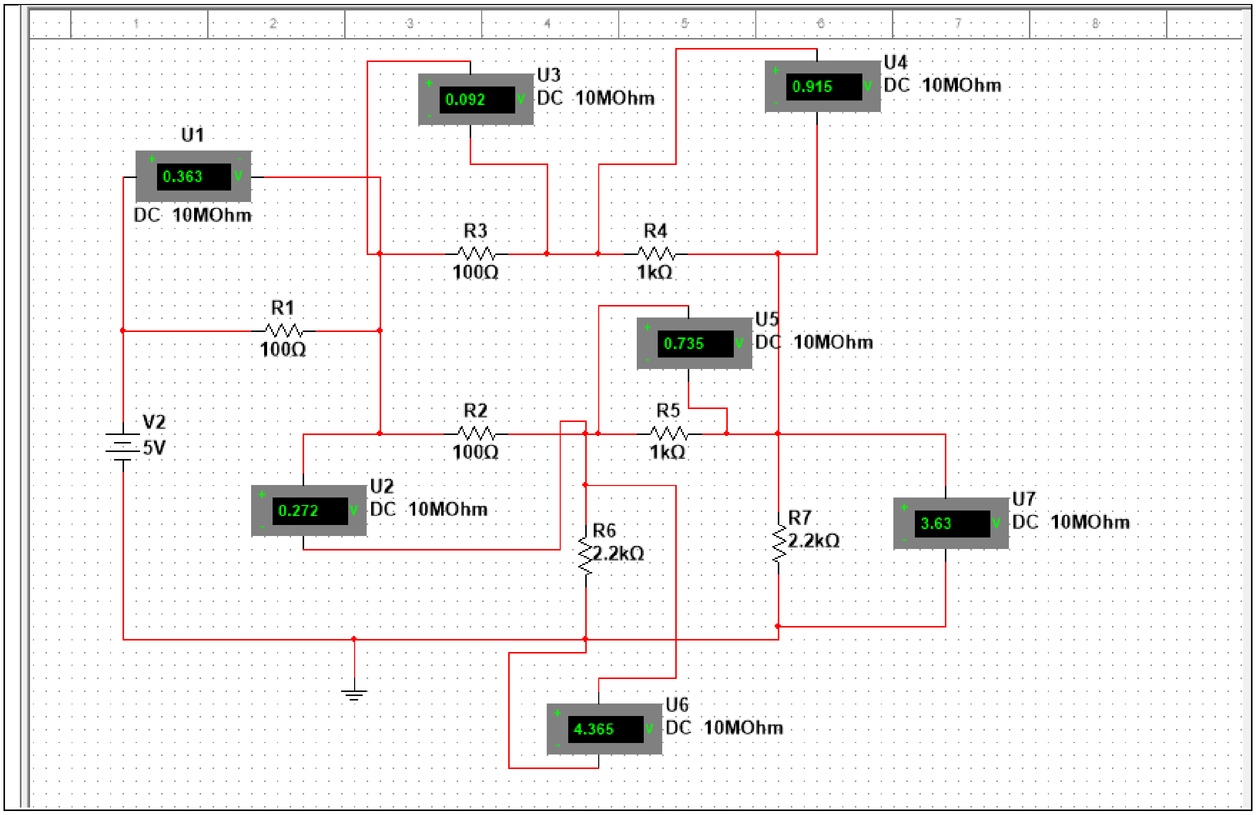
$R_1 = R_2 = R_3 = 100\Omega$.

$R_4 = R_5 = 1k\Omega$.

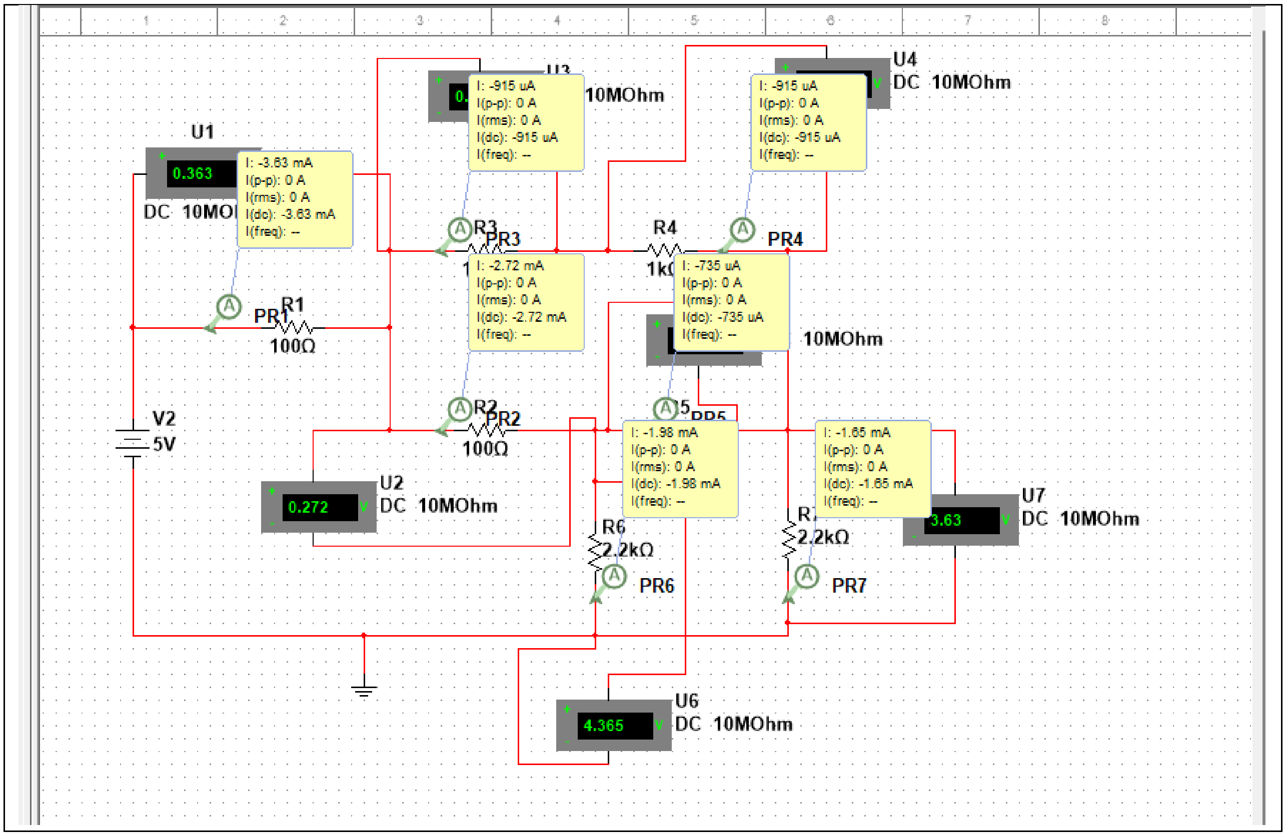
$R_6 = R_7 = 2.2k\Omega$.

After building the circuit in Multisim and measuring the figures, the results below were obtained:

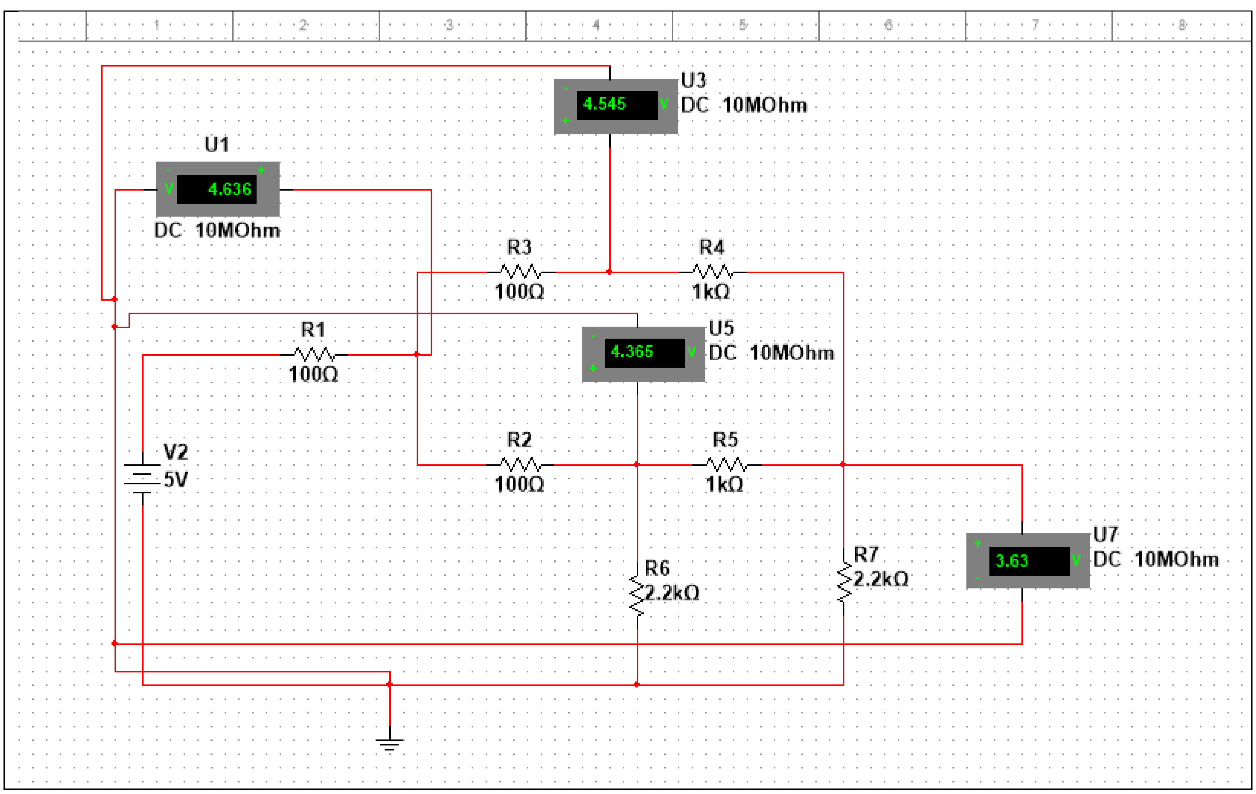
Branch Voltages:



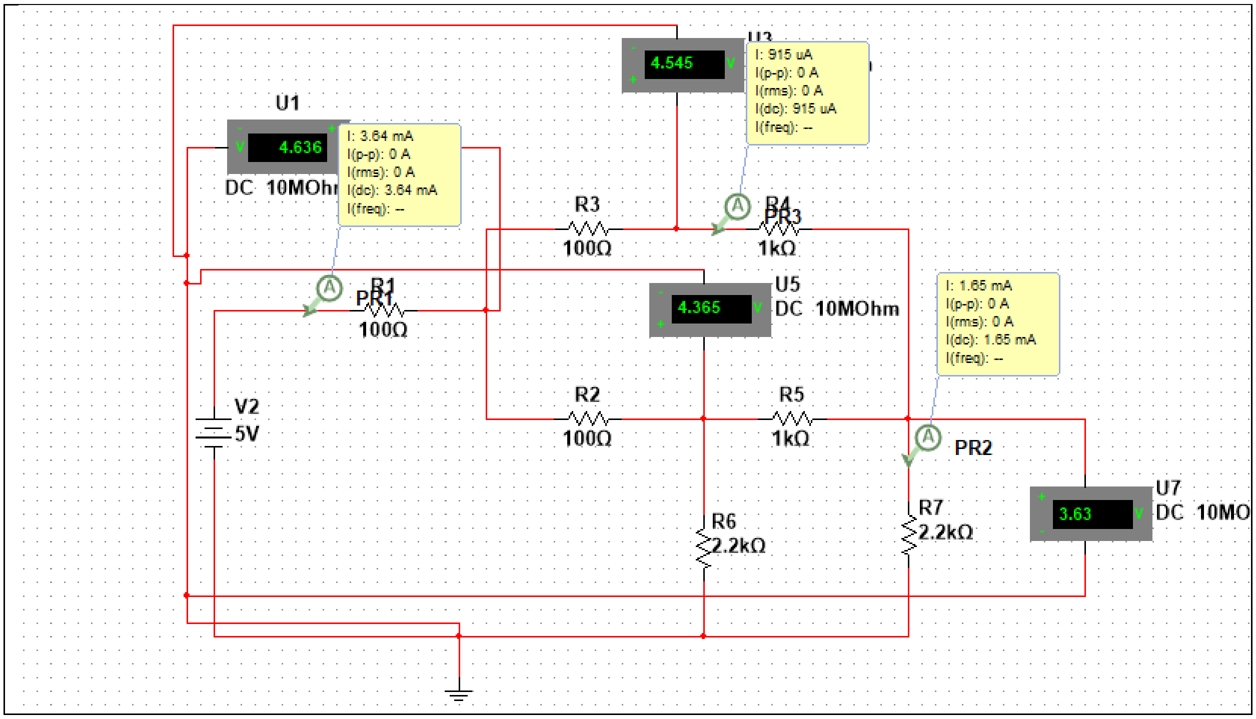
Branch Currents:



Node Voltages:



Loop Currents:



The results are tabulated in the table below:

Branch Voltages (V)	Branch Currents (mA)	Node Voltages (V)	Loop Currents (mA)
$V_{R1} = 0.363$	$i_{R1} = 3.63$	$V_1 = 4.636$	$I_1 = 3.63$
$V_{R2} = 0.272$	$i_{R2} = 2.72$	$V_2 = 4.545$	$I_2 = 1.65$
$V_{R3} = 0.092$	$i_{R3} = 0.915$	$V_3 = 4.365$	$I_3 = 0.915$
$V_{R4} = 0.915$	$i_{R4} = 0.915$	$V_4 = 3.63$	
$V_{R5} = 0.735$	$i_{R5} = 0.735$		
$V_{R6} = 4.365$	$i_{R6} = 1.98$		
$V_{R7} = 3.630$	$i_{R7} = 1.65$		

We can easily verify Ohm’s law by looking at the figures above. We know that according to Ohm’s law, V = I*R, i.e for a linear resistor, voltage across is directly proportional to the current.

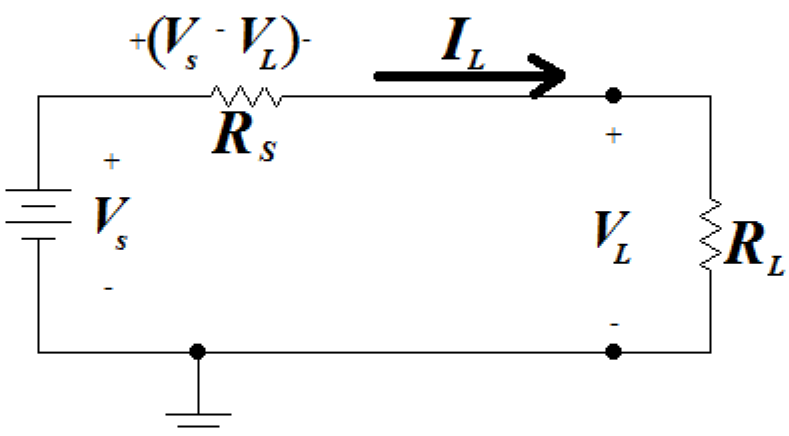
If we take, for example, Resistor 1, (R1 in the diagram, which is 100 Ohms), the current flowing through R1 is 3.63 milliamps, we must first convert that into Amps to compare with Voltage (or convert Voltage to millivolts). Therefore, current (in Amps) flowing through R1 is 0.00363 Amps. To determine the voltage, we can apply that to the formula for Ohm's law, and we see that 0.00363*100 is indeed equal to 0.363, which is the Voltage we measured across that resistor.

Kirchhoff's Voltage Law (KVL) states that the sum of the voltages around any closed path or loop in a circuit must equal zero. Looking at the closed loop on the left hand side, with a provided Voltage Source of 5V, we know that the voltages flowing across R1, R2, R6 must be equal to 5V as well. From the results table above, we can see that by adding Voltages across those resistors (0.363+0.272+4.365 = 5), and thus KVL is verified.

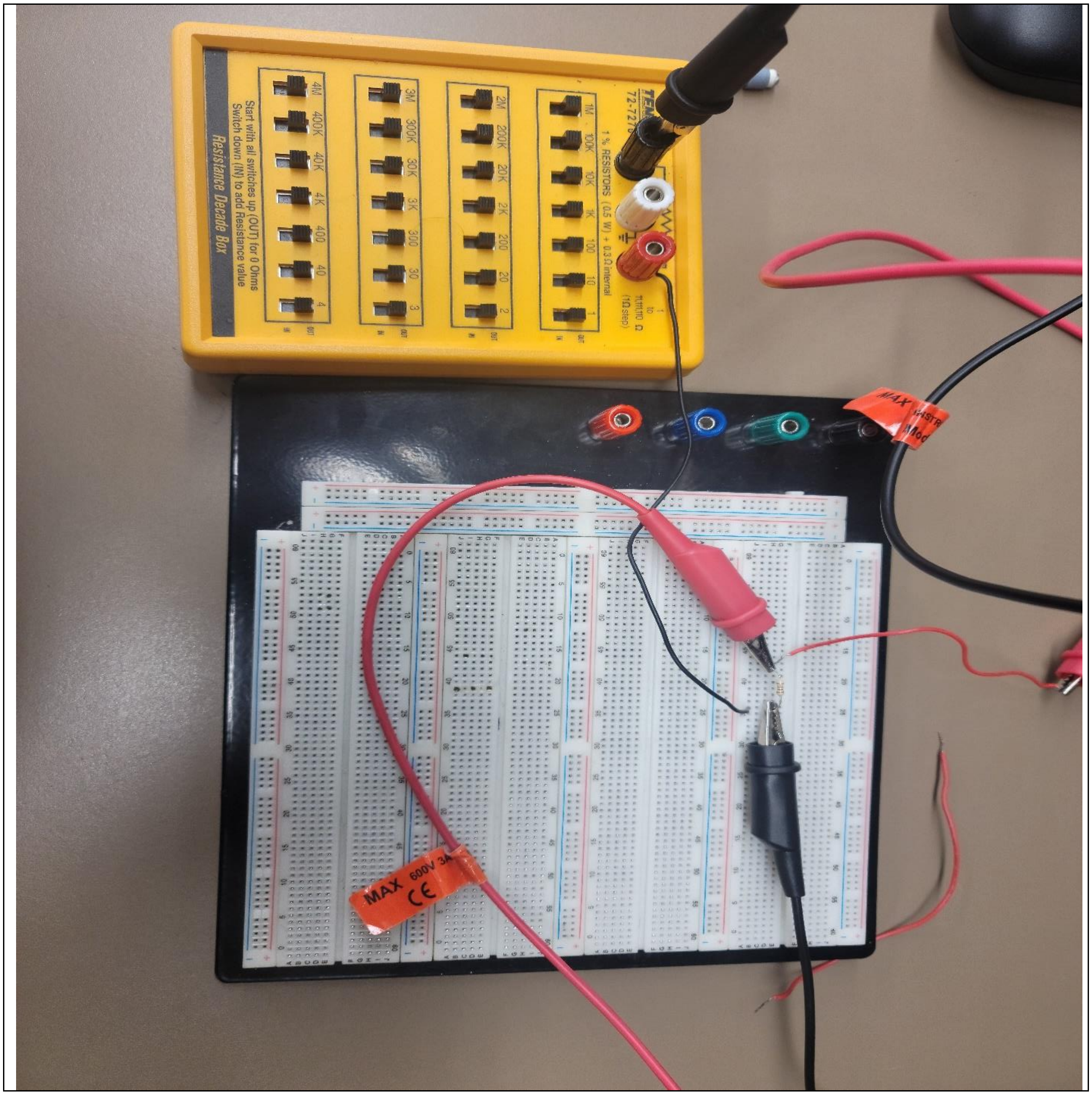
Kirchhoff's Current Law simply states that the sum of currents entering a node must be equal to the sum of currents leaving that node. Once again, going to our table of results above, the current flowing through R1 enters node V_1 and the currents flowing through R2 and R3 leave that node. Therefore, we can see that if we add the current values for R2 and R3, we get roughly the same figure for current flowing through R1, i.e. (2.72 + 0.915 ≈ 3.63), KCL is verified.

PART B:

Part B of this lab involved building the circuit below:



In this part, I built the circuit using a breadboard, some wires and resistors in a simple laboratory setup as below:

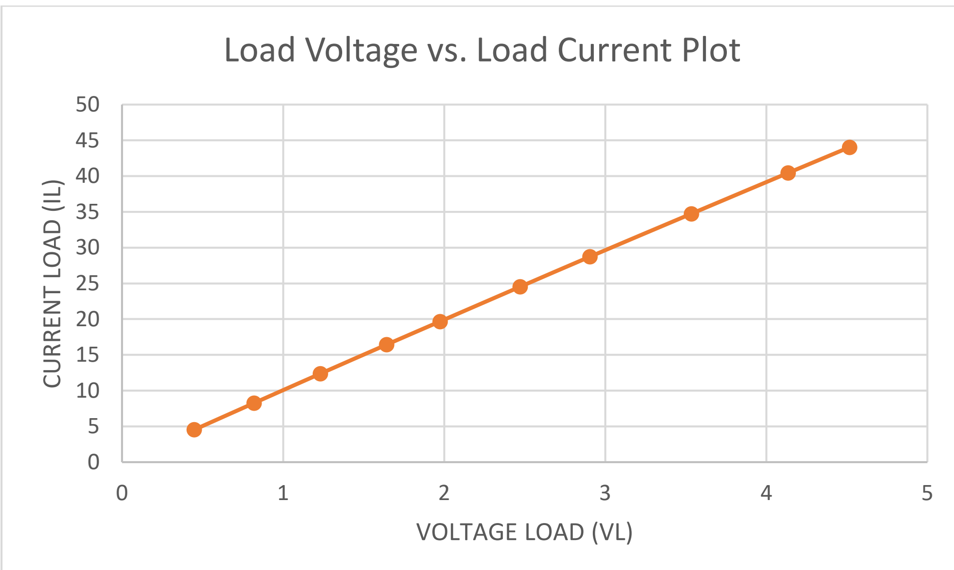


We also connected a Voltmeter to the setup and set the source voltage to 5V. The source resistor was set to 100 Ohms. We then connected the resistor load wire to the resistor box and tested various values of the load resistance. The results are tabulated in the figure below:

R_L (Ohms)	V_L (V)	I_L (mA)
10	4.517	44.04
20	4.135	40.44

40	3.536	34.75
70	2.906	28.74
100	2.472	24.53
150	1.975	19.68
200	1.643	16.44
300	1.232	12.38
500	0.821	8.28
1000	0.449	4.54

Plotting the values for V_L and I_L we get the chart below:



We can see the relationship between Voltage and Current. As Voltage is increased, Current also increases, hence reflecting the direct proportionality between both values across different Resistor values, according to Ohm's law.

In conclusion, this lab was good practice to review Ohm's law and KCL/KVL among other concepts.