Summer 2023

EEE/ETE 111L

Analog Circuits-I Lab (Sec-11)

Faculty: Professor Dr. Monir Morshed (DMM)

Instructor: Rokeya Siddiqua

Lab Report 02: Zener Diode Applications.

Date of Performance:
19 August 2023

Date of Submission:
26 August 2023

Group no.: 05

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2. Sabrina Haque Tithi- 2031265642
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4. **Joy Kumar Ghosh – 2211424642**
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Objective:

- Study of the Zener Diode application.
- I-V Characteristic of Zener Diode.

Theory:

The diode we studied earlier in the last lab, can't operate in negative voltage, because this may damage their internal system. Today we studied the Zener diode, it's different than the one before.

A Zener diode is a specialized semiconductor device that allows current to flow in reverse direction when the voltage accross it reachs a specific threshold, known as the Zener voltage. This characteristic makes it useful for voltage regulation and protection in various electronic circuits.

The symbol and the characteristic graph of Zener diode:

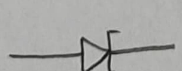


Fig-2.1: Symbol of Zener Diode

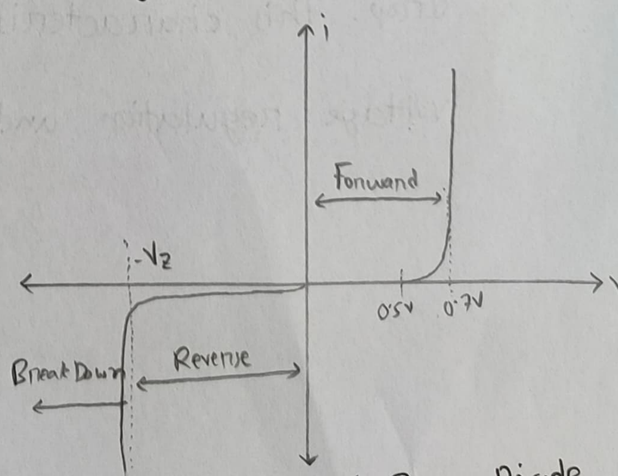


Fig-2.2: I-V Characteristic of Zener Diode

Operation mode of Zener Diode:

Forward Bias: In this mode, the diode conducts current in the forward direction when a voltage greater than its forward voltage threshold is applied across its terminals. It behaves like a typical diode, allowing current flow.

Leakage Current: When the applied voltage is below the Zener voltage, a small reverse leakage current flows through the diode. This current is minimal and typically not of practical significance.

Reverse Breakdown: Once the reverse voltage surpasses the Zener voltage, the diode enters breakdown. It allows controlled reverse current to flow, maintaining a constant voltage drop. This characteristic makes Zener diodes useful for voltage regulation and reference applications.

List of Equipment:

SN	Component Details	Specification	Quantity
1.	Zener Diode	5 volts	1 piece
2.	Resistor	220Ω, 470Ω, 1kΩ	1 piece each
3.	POT	10kΩ	1 unit
4.	Trainer Board		1 unit
5.	DC Power Supply		1 unit
6.	Digital Multimeter		1 unit
7.	Chords & wire		as required

Circuit Diagram:

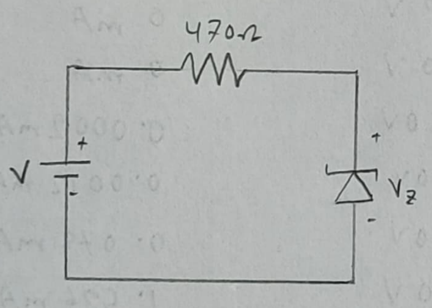


Fig-2.3: Experimental Circuit I
(Reverse Bias)

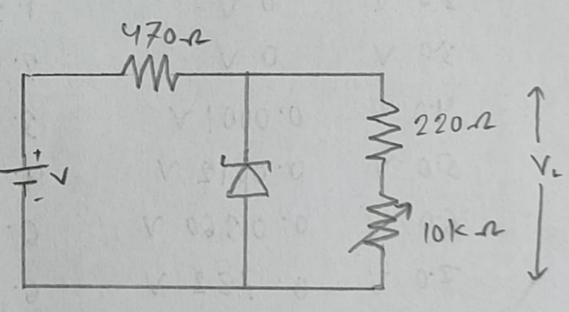


Fig-2.4: Experimental Circuit II
(Load Regulation)

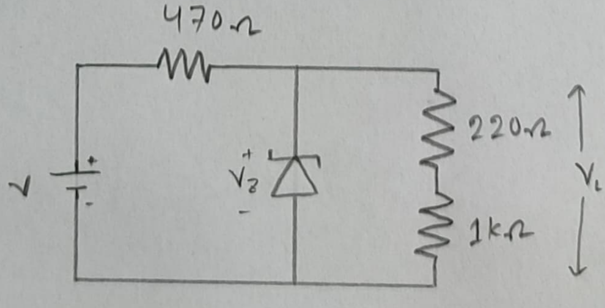


Fig-2.5: Experimental Circuit III
(Line Regulation)

Data Table:

Theoretical	Practical
470 Ω	0.461 kΩ
220 Ω	0.216 kΩ
1 kΩ	0.987 kΩ

Table 2.1: Data for I-V characteristics:

V (volts)	V_R (volts)	V_Z (volts)	$I_Z = \frac{V_R}{R}$ (mA)
0.1 V	0 V	0.029 V	0 mA
0.5 V	0 V	0.429 V	0 mA
1.0 V	0 V	0.975 V	0 mA
2.0 V	0 V	1.929 V	0 mA
3.0 V	0 V	3.010 V	0 mA
4.0 V	0.0001 V	3.960 V	0.0002 mA
5.0 V	0.0012 V	4.960 V	0.0012 mA
6.0 V	0.0360 V	6.000 V	0.078 mA
7.0 V	0.782 V	6.160 V	1.696 mA
8.0 V	1.862 V	6.180 V	4.039 mA
9.0 V	2.742 V	6.190 V	5.947 mA
10.0 V	3.724 V	6.210 V	8.078 mA

Table 2.2: Data for Load Regulation

POT R (kΩ)	Measured R (kΩ)	V_{220} (mV)	V_L (volts)	I_L (Amp) = $\frac{V_{220}}{220}$
1 kΩ	1.216 kΩ	992 mV	6.140 V	0.0046 A
2 kΩ	1.984 kΩ	613 mV	6.190 V	0.0028 A
3 kΩ	2.844 kΩ	446 mV	6.200 V	0.0021 A
4 kΩ	4.140 kΩ	307 mV	6.200 V	0.0014 A
5 kΩ	5.060 kΩ	262 mV	6.210 V	0.0012 A
6 kΩ	5.930 kΩ	219 mV	6.210 V	0.0010 A
7 kΩ	6.970 kΩ	189 mV	6.210 V	0.0008 A
8 kΩ	8.020 kΩ	163 mV	6.210 V	0.0007 A
9 kΩ	8.970 kΩ	146 mV	6.210 V	0.0006 A
10 kΩ	9.850 kΩ	133 mV	6.210 V	0.0006 A

Table 2.3: Data for Line Regulation

V (volts)	V_L (volts)
1 V	0.685 V
3 V	2.170 V
5 V	3.588 V
6 V	4.300 V
7 V	5.070 V
8 V	5.750 V
9 V	6.160 V
10 V	6.160 V
11 V	6.180 V
12 V	6.210 V

Results:

From the graph 2·1 (I_z vs V_z) we can see that, when the zener voltage is 6·120V, current started to rises rapidly.

Therefore,
Zener Break Down voltage is 6·120 V.

From the graph 2·2:(I_L vs V_L)

$$\text{Load Regulation} = \frac{6{\cdot}2-6{\cdot}17}{0{\cdot}0042-0{\cdot}0029} \cancel{\times 100\%}$$

$$= 23$$

From the graph 2·3: (V_L vs V)

$$\text{Line Regulation} = \frac{\Delta V_L}{\Delta V} = \frac{3{\cdot}2-2{\cdot}8}{4{\cdot}47-3{\cdot}88} = 0{\cdot}68$$

Discussion:

In this experiment, first we observed the I-V characteristic of a Zener diode in reverse bias mode. We found that the voltage drop accross the zener diode was increasing with supplied voltage. But when it reached around 6.20 V, it stopped increasing and maintaining a constant voltage drop. Also, we observed that current flow increases exponentially after the constant voltage drop. We recognized that this it is the Zener breakdown voltage.

Then we observed again using a POT resistor. In this time, we found, there was a constant voltage drop in parallel to the Zener diode. Resistance didn't affect the diode's voltage drop.

Then we again cheaked by fixing the resistance in the place of POT resistors. This time, we found that when the supplied voltage was reached around 10V, Voltage in parallel to the diode, maintain a constant voltage drop again.

In this experiment we faced a problem regarding the POT resistance. It wasn't giving stable resistance; it was always buffering the resistance. After changing the equipment, we got a stable output from the POT resistor, but we were unable to fix it in our preferred resistance. So, with the suggestion by the instructor, we took resistance around our prefered value and note it in an extra column.

In short, we studied the Zener diode applications.

Simulation: Attached.

Graph: Attached.

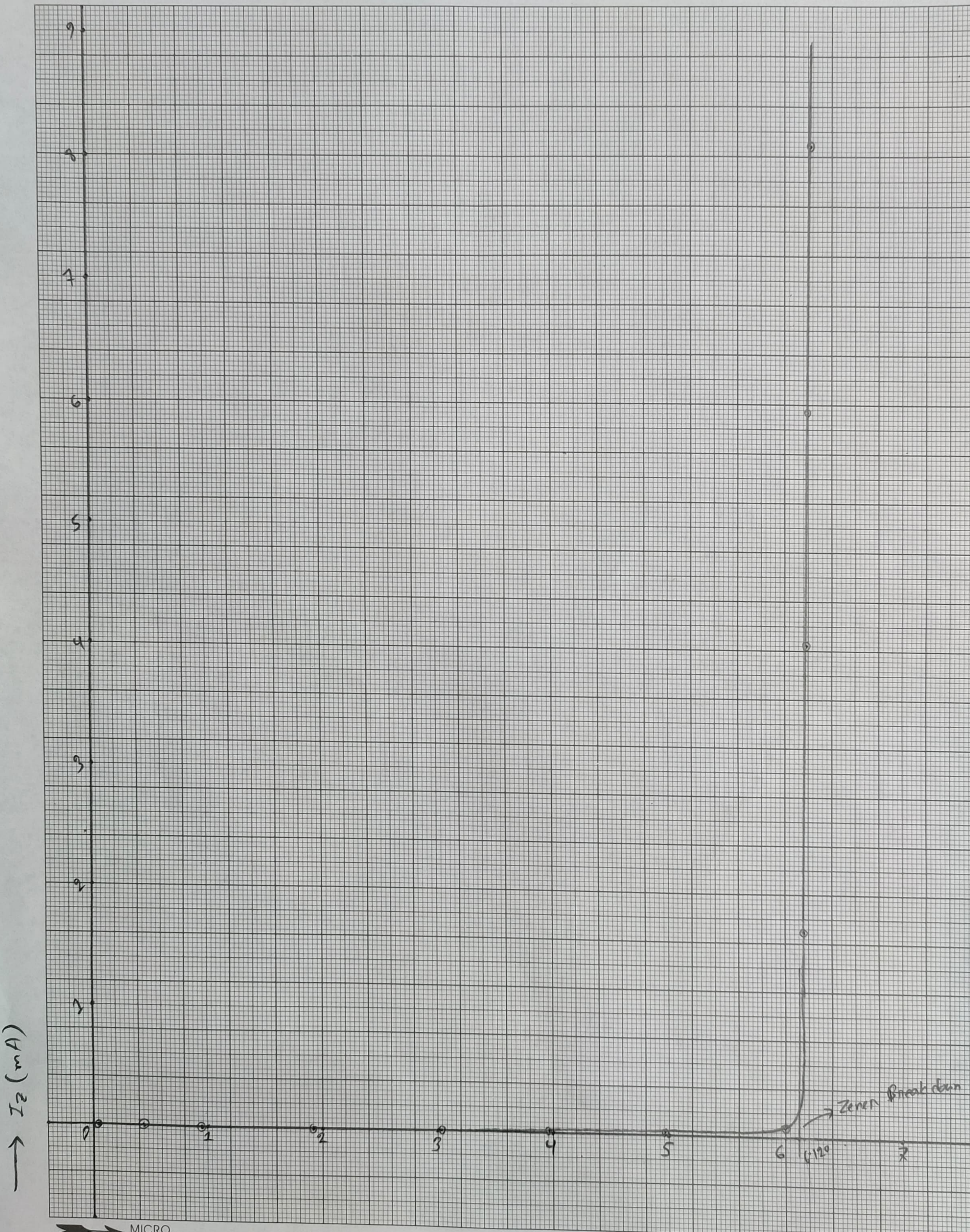
Attachment:

1. Signed Data Table.
2. 3x Simulation.
3. 3x Graph.

Contribution:

SN	Name	ID	Contribution
01	Mahmudul Hasan	2011551043	Circuit buid and measurement for the circuit-1.
02	Sabrina Haque Tithi	2031265642	Absent due to Dengue
03	Afrin Akter	2112246642	Operate POT Resistor, Circuit Buid 2, Data writing
04	Joy kumar Ghosh	2211424642	DC Power Supply, Half measurement of Circuit 2, Full Report writing
05	Sazid Hasan	2211513642	Circuit Build-3, half measurement of 2 and full measurement of 3

Roll No. ....

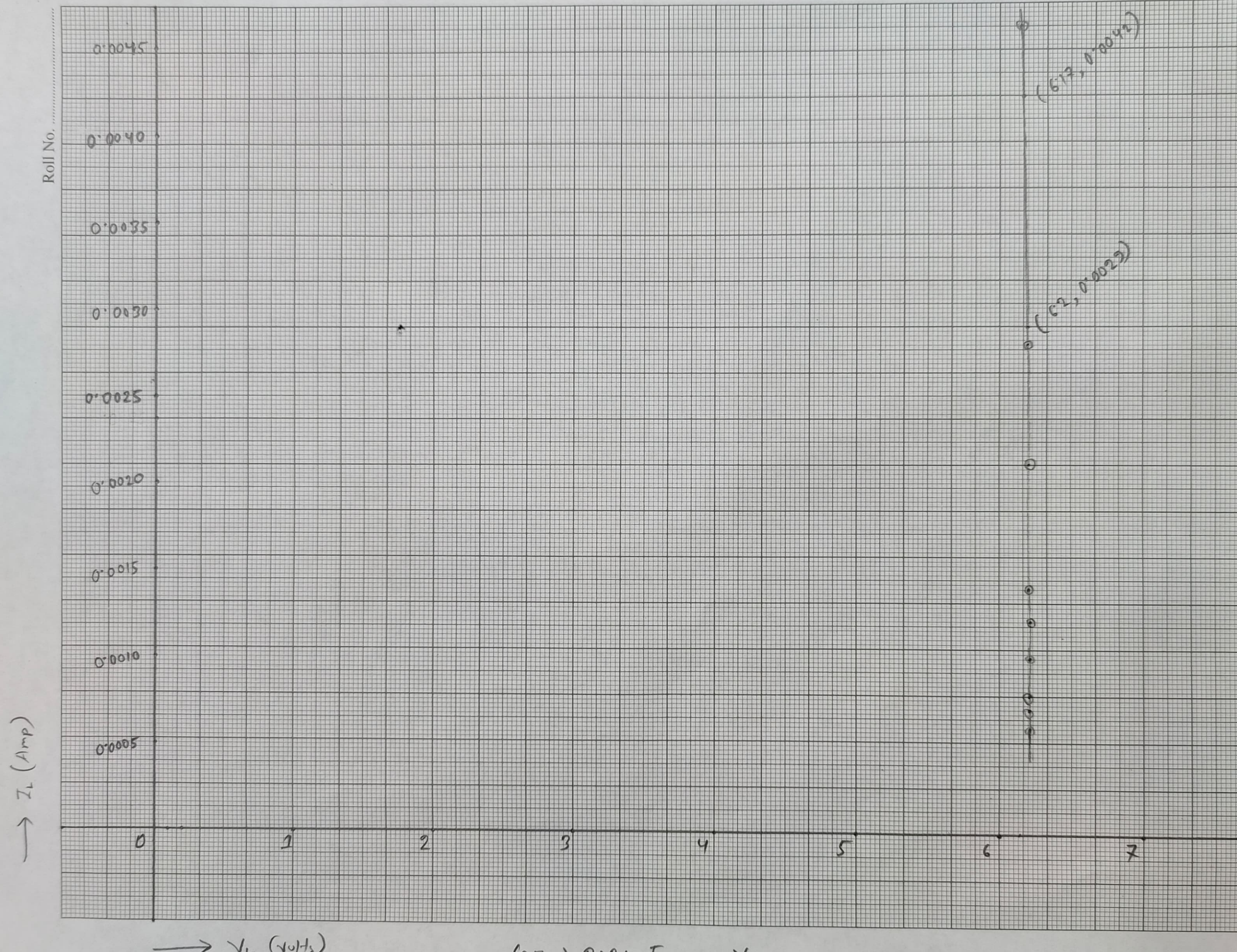


→ V_z (Volt)

Graph 2.1: I_z vs V_z

N.P. 20 cm x 25 cm

Roll No. ....

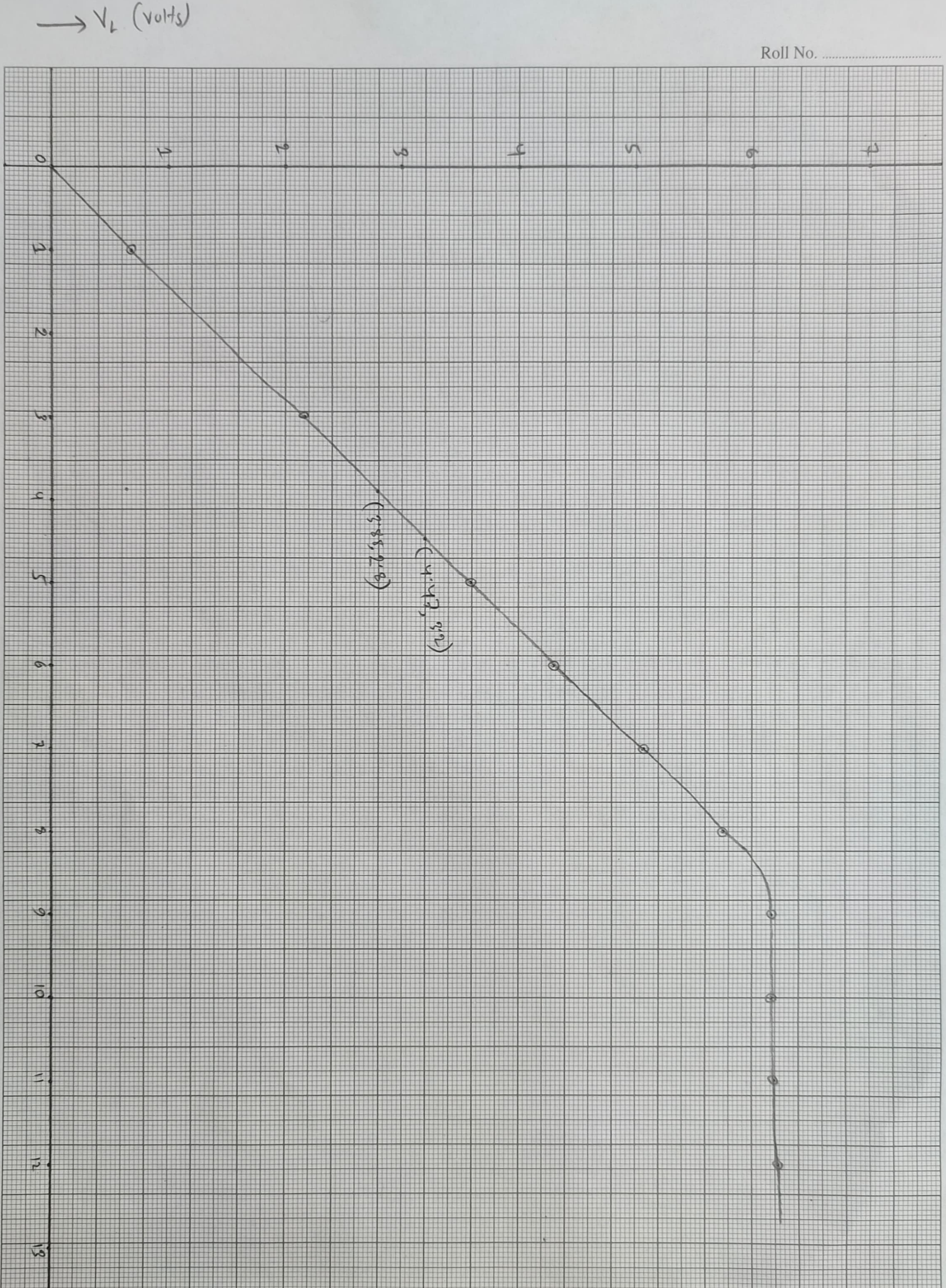


Graph 2·2: I_L vs V_L

MICRO

N.P. 20 cm x 25 cm

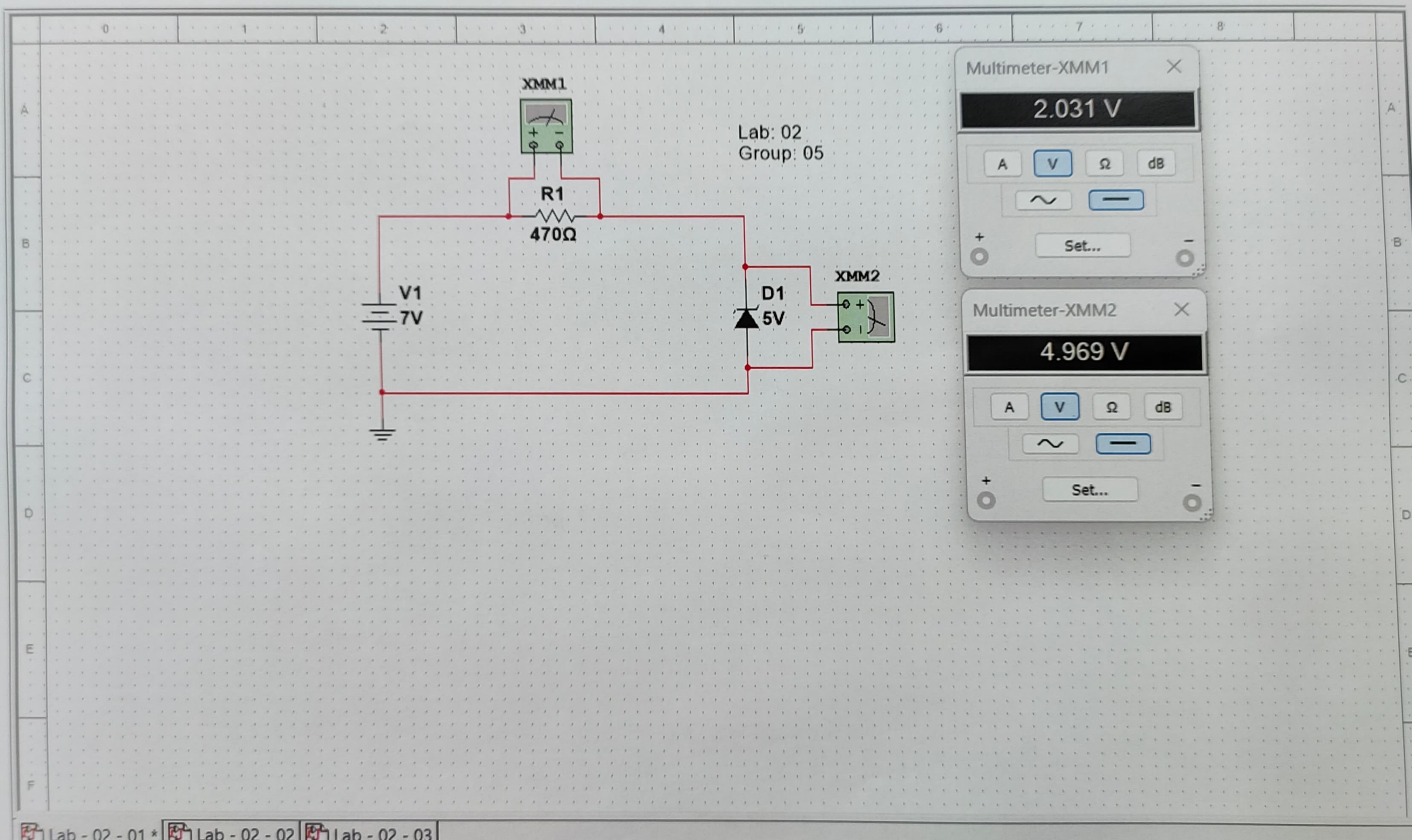
Roll No. ....

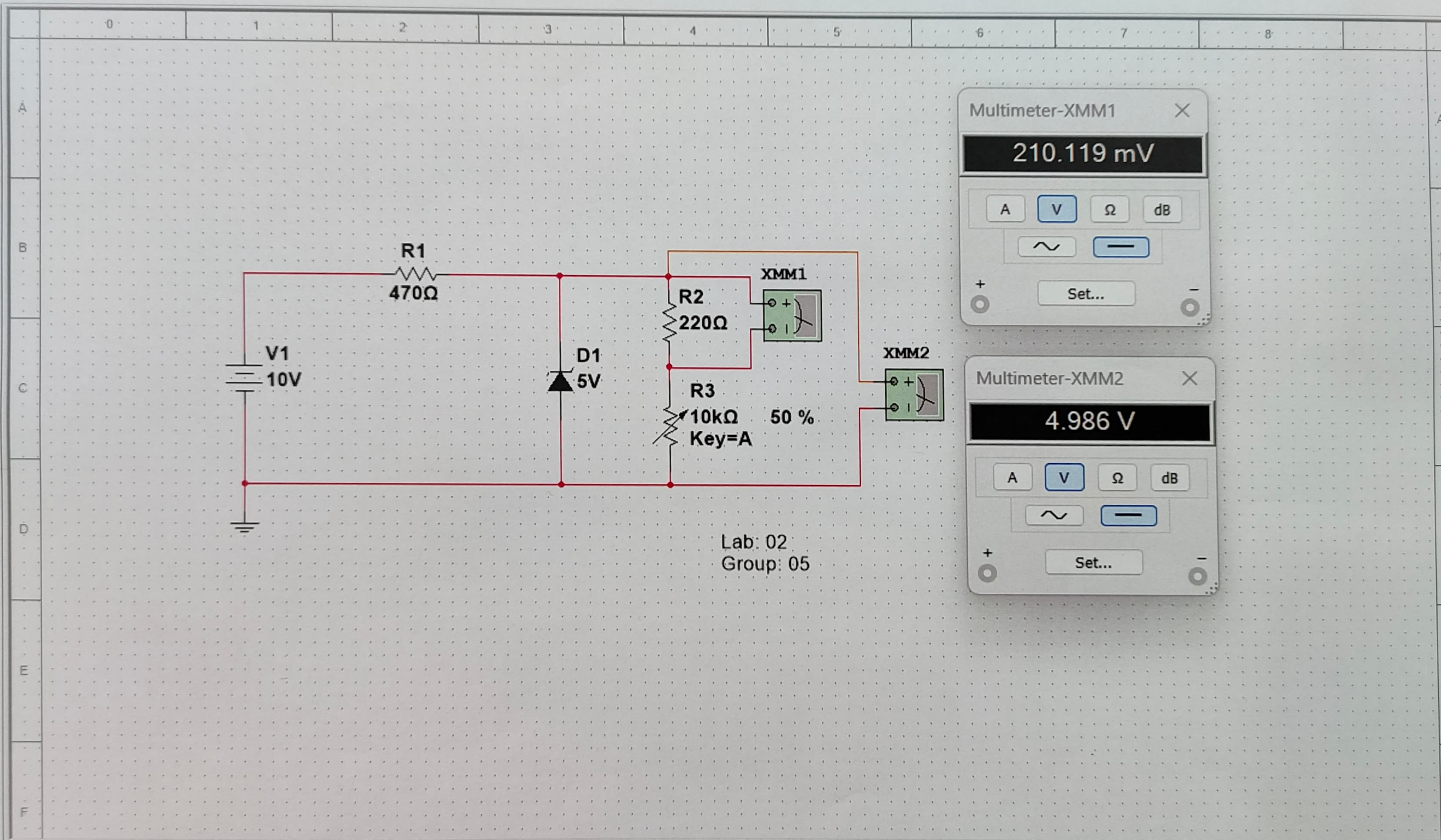


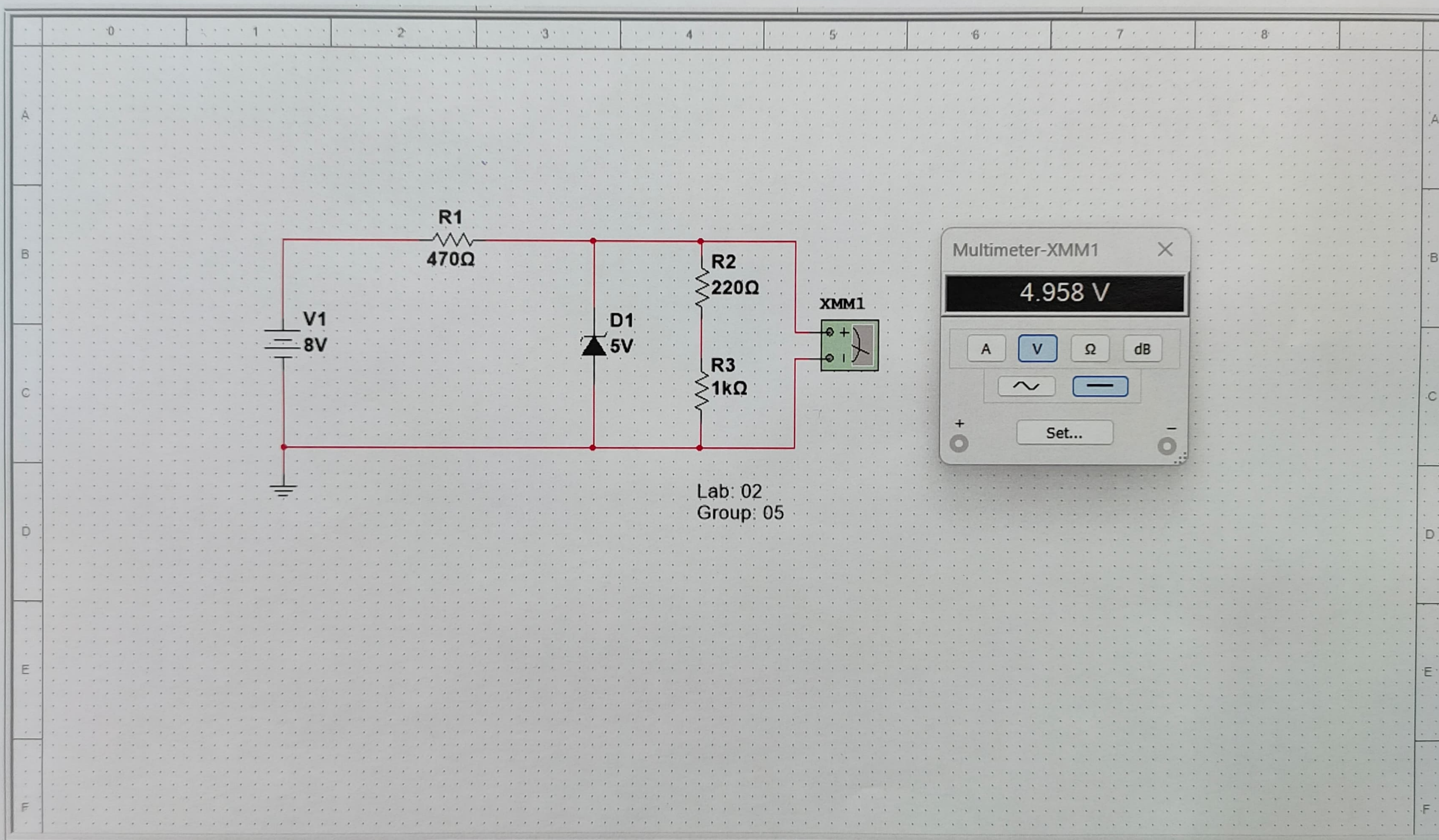
Graph 2·3: V_L vs V

MICRO

N.P. 20 cm x 25 cm


XMM1
R1
470Ω
V1
7V
D1
5V
XMM2
Lab: 02
Group: 05
Multimeter-XMM1
2.031 V
A
V
Ω
dB
Set...
+
-
Multimeter-XMM2
4.969 V
A
V
Ω
dB
Set...
+
-
Lab - 02 - 01 *
Lab - 02 - 02
Lab - 02 - 03


R1
470Ω
V1
10V
D1
5V
R2
220Ω
R3
10kΩ
50 %
Key=A
XMM1
XMM2
Lab: 02
Group: 05
Multimeter-XMM1
210.119 mV
A
V
Ω
dB
Set...
Multimeter-XMM2
4.986 V
A
V
Ω
dB
Set...


R1
470Ω
V1
8V
D1
5V
R2
220Ω
R3
1kΩ
XMM1
Lab: 02
Group: 05
Multimeter-XMM1
4.958 V
A
V
Ω
dB
Set...

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Procedure:

1. Connect the circuit as shown in the figure 3.3
2. Vary the supply voltage from zero volt, complete the Table 3.1.
3. Connect the circuit as shown in the figure 3.4
4. Keep the POT at maximum position and power up the circuit.
5. Gradually decrease the POT resistance and complete the Table 3.2.
6. Replace the POT with 1KΩ resistance, vary the supply voltage and take reading for Table 3.3.

Data Collection:

Signature of instructor:

Experiment: 3,
Performed by Group# ______

Theoretical	Practical
470Ω	461Ω = 0.461kΩ
220Ω	216Ω = 0.216kΩ
1KΩ	0.987 kΩ

Rsiddiqua
19.08.23

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Report:

1. Plot I_Z *vs* V_Z characteristics of Zener diode. Determine the Zener breakdown voltage from the plot.
2. Plot I_L vs V_L for the data table 4.2. Scale [x-axis: 0.1V/DIV, y-axis: any suitable range]. Find the Load regulation from the graph.
3. Plot V_L vs V for the data table 4.3. Find the line regulation from graph.