Department of Computer Science and Engineering

Institute of Science and Technology, National University

Lab Report

Submitted To:

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Designation	Lecturer
Course Title	Electrical and Electronic Circuit Lab
Course Code	510204
Date of Submission	12 September 2023

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Date of Submission	12 September 2023

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Experiment no. 01

Name of the experiment: Verification of ohm's law for resistance used in Laboratory.

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Institute of science and Technology

25/08/2023

Experiment no.01

Name of the experiment : Verification of ohm's Law for resistance used in laboratory.

Objectives :

- To become familiar with the use of a digital voltmeter and ammeter to measure DC Voltage and current.
- To construct series and parallel circuits using resistor, wires and a bread-board from a circuit diagram.
- To test the validity of ohm's Law.
- To observe the Linear dependence of current on voltage for a fixed resistance.
- To determine the resistance relation between current and voltage.

Theory : Ohm's Law states that,

"The ratio of potential difference V between any two points on a conductor to the current I flowing between them is constant, provided the temperature of the conductor doesn't change."

In other words,

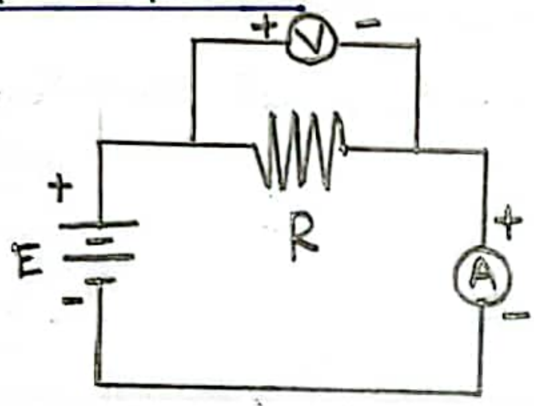
$$\frac{V}{I} = \text{constant}$$

$$\Rightarrow \frac{V}{I} = R$$

$$\therefore V = IR$$

where R is the resistance between two points.

Working diagram:



Apparatus:

- Variable power supply.
- Connecting wires.
- Bread board
- Voltmeter
- Resistor
- Ammeter

Procedure:

- Connecting the power supply, resistor, ammeter in series and voltmeter in in parallel connection across the resistor in the breadboard.

- By turning on the power supply, giving voltage to the circuit.
- Noting down the voltmeter and ammeter data in the data table.
- Repeating 2nd and 3rd steps several times in different voltage.
- A VI curve is plotted according to the readings.

Results :

No. of observation	Voltage (V) volt	Current (I) mA	Resistance $R = V/I$ Ω	Average resistance practical R_p	Resistance theoratical R_t
01	5 V	9 mA	555.5 Ω	560 Ω	555.5 Ω
02	5.14 V	9.2 mA	558.69 Ω	553 Ω	558.69 Ω
03	5.07 V	15.3 mA	331.3 Ω	333 Ω	331.3 Ω
04	5.21 V	9.1 mA	572.52 Ω	560 Ω	572.52 Ω
05	4.83 V	8.47 mA	570.24 Ω	547 Ω	570.24 Ω

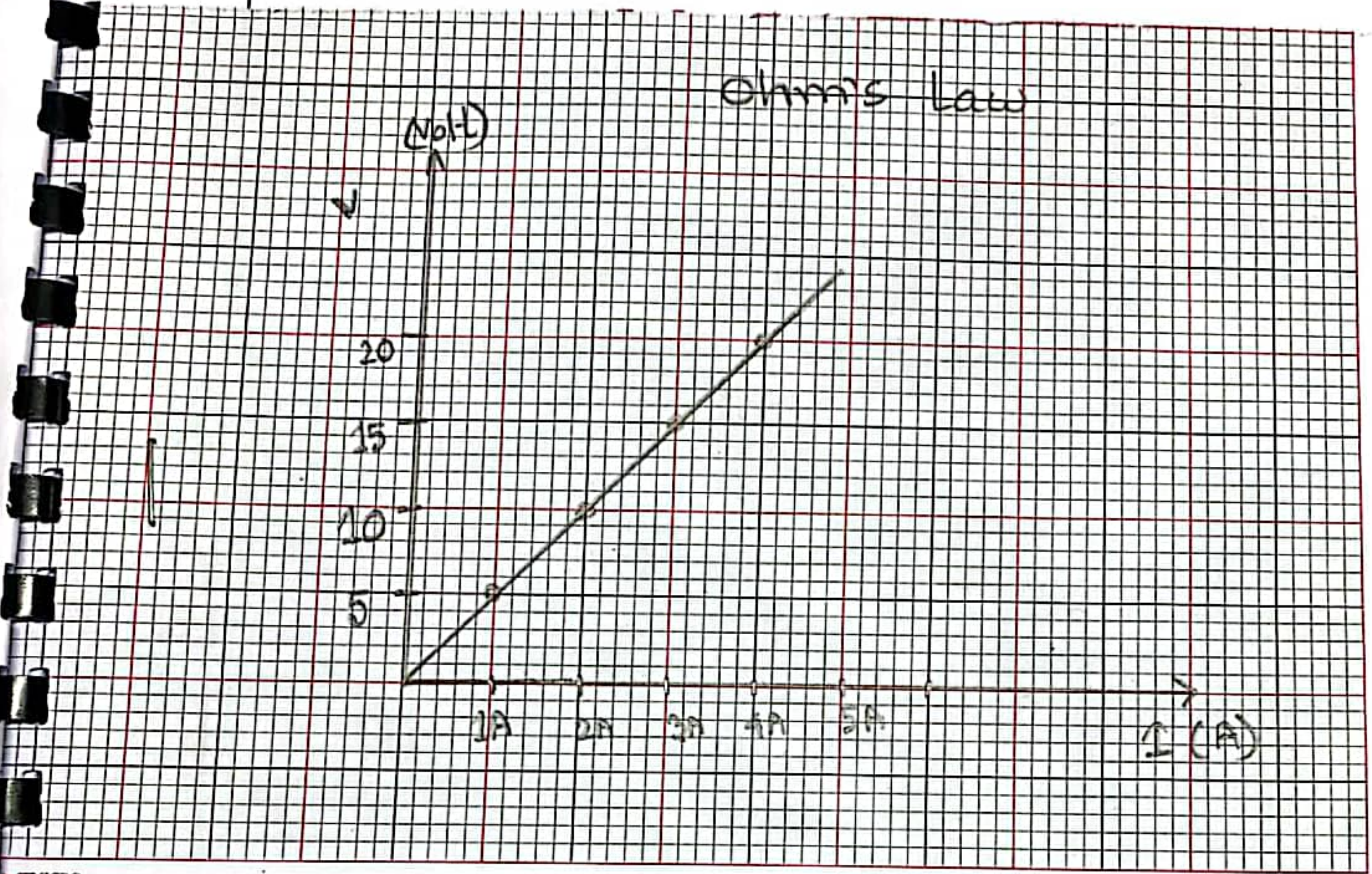
Error :

$$\text{Percentage of error} = \frac{R_t - R_p}{R_t} \times 100\%$$

$$= \frac{558.59 - 559}{558.69} \times 100\%$$

$$= 1.01\%$$

Graph :



MICRO 8 Inch x 10 Inch

Precaution :

- The connection should be correctly inputed in breadboard.
- Taking the magnitude often, stop Jumping in the meters.
- The calculation should be done correctly.

Discussion :

After the experiment, we understand how to apply ohm's law in various situation. By observing and calculating the value of voltage, current and resistance, the ohm's law is verified. The error is negligable and the V-I graph is linear.

References:

- Robert L. Boylested - "Inductory circuit Analysis."
- B.L Theraja and A.K. Theraja - " A textbook of Electrical Technology " Volume-I .

Experiment no: 02

Name of the experiment: Verification of Kirchhoff's voltage law.

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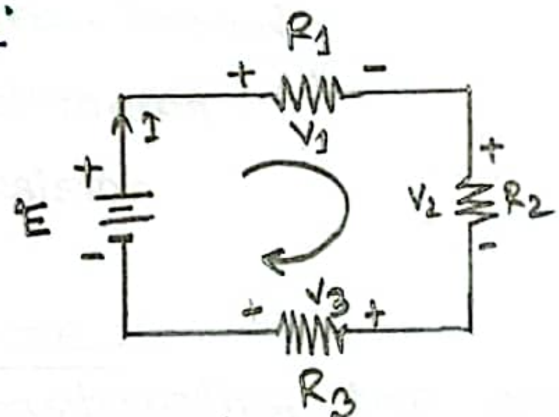
Experiment no.02

Name of the experiment: Verification of Kirchhoff's voltage law (KVL).

Objectives:

- To study and verify kirchhoff's voltage law.
- To observe voltage drops in a closed circuit.

Theory:



Fig(1)

Kirchhoff's voltage law state that,

"The algebric sum of the potential rises and drops around a closed loop or path of a circuit is zero."

According to fig(1),

$$E - IR_1 - IR_2 - IR_3 = 0$$

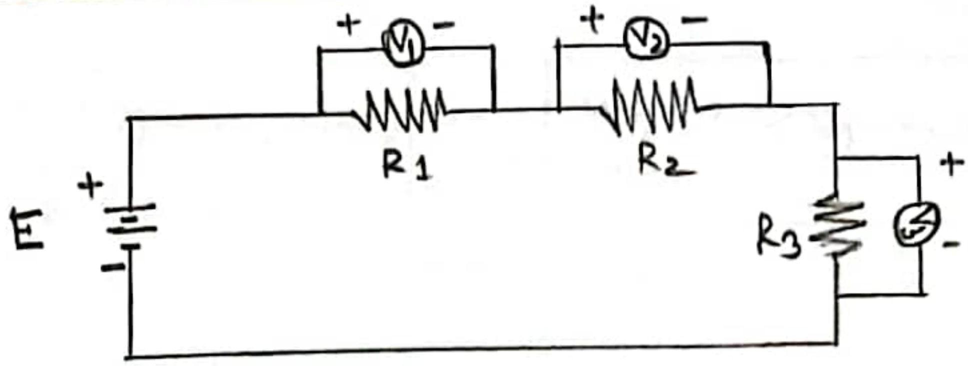
$$\Rightarrow E = IR_1 + IR_2 + IR_3$$

$$\Rightarrow E = V_1 + V_2 + V_3$$

$$\therefore E = \Sigma V$$

where E is voltage rise and V is voltage drop.

Working diagram :



Apparatus :

- Variable power supply
- connecting wires
- Bread board
- Voltmeter
- Resistor

Procedure :

- Constructing the circuit on the bread-board, according to the working diagram.
- Connecting voltmeter in parallel with the resistors.
- Taking readings from the voltmeter for various supply voltages.
- At last, calculating the error.

Result :

No. of observation	voltage rise, E (volt)	V_1 (volt)	V_2 (volt)	V_3 (volt)	$\Sigma V_1+V_2+V_3$
01	5 V	1.4 V	0.8 V	2.6 V	4.8 V
02	10 V	2.8 V	1.7 V	5.3 V	9.9 V
03	15 V	4.4 V	2.6 V	7.9 V	14.9 V

Error :

For E = 5 volt,

$$\text{Error} = \frac{E - \Sigma V}{E} \times 100\%$$

$$= \frac{5-4.8}{5} \times 100\% = 4\%$$

For E = 10 volt,

$$\text{Error} = \frac{10-9.9}{10} \times 100\%$$

$$= 1\%$$

For E = 15 volt,

$$\text{Error} = \frac{15-14.9}{15} \times 100\%$$

$$= 0.67\%$$

Precaution :

• While supplying power, the multimeter should never be connected directly with the end of battery, it can damage the meter.

• All the elements should be used carefully.

• The Readings should be taken correctly.

• After the experiment, power supply should be switched off.

Discussion: We should be carefull while performing the experiment. By observing the values, here kirchhoff's voltage law is verified. The errors are negligible which may have occured for the rounding error. Thus the experiment is done successfully.

Reference :

- Robert L. Boylested – "Introductory circuit Analysis"
- B.L Theraja and A.K. Theraja – " A textbook of Electrical Technology ". volume – I

Experiment no : 03

Name of the experiment : Verification of Kirchoff's current law.

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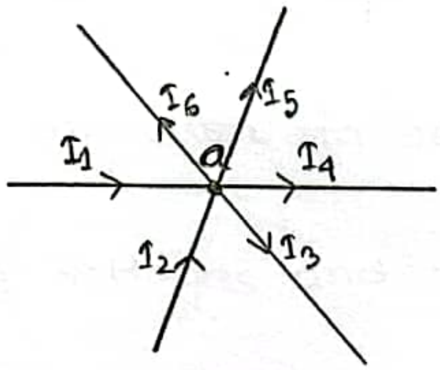
Experiment no. 3

Name of the experiment: Verification of Kirchhoff's current law (KCL).

Objective:

- To observe the characteristics of a parallel DC circuit.
- To study and verify Kirchhoff's current law.

Theory: Kirchhoff's current law states that, "The algebric sum of current entering in a system, junction or node is equal to the sum of current leaving that junction."



fig(1)

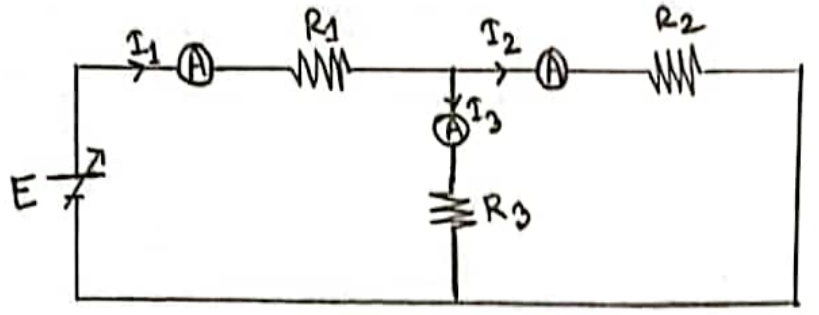
From fig(1) at a point,

$$I_1 + I_2 - I_3 - I_4 - I_5 - I_6 = 0$$

$$\Rightarrow I_1 + I_2 = I_3 + I_4 + I_5 + I_6$$

$$\therefore \Sigma I_{entering} = \Sigma I_{leaving}$$

Working diagram :



Apparatus :

- Resistor
- Ammeter
- Bread board
- connecting wire
- Variable power supply

procedure :

- Setting up all the components as the working diagram.
- Connecting ammeter in series to the resistor.
- Increasing voltages and repeating the above process.
- Noting down the readings in the table and calculating the error.

result:

No of observation	E (volt)	I_1 (mA)	I_2 (mA)	I_3 (mA)	$\Sigma\ I_2+I_3$ (mA)
01	5 V	5.28mA	1.89 mA	3.38 mA	5.27 mA
02	5V	22.2 mA	5.5 mA	16.6 mA	22.1 mA
03	5V	9.1mA	5.2mA	3.9 mA	9.1 mA

Error:

For E = 5 volt,

$$\text{error} = \frac{I_{entering} - I_{leaving}}{I_{entering}} \times 100\%$$

$$= \frac{5.28 - 5.27}{5.28} \times 100\%$$

$$= 0.18\%$$

For E = 5 volt,

$$\text{Error} = \frac{22.2 - 22.1}{22.2} \times 100\%$$

$$= 0.45\%$$

For E = 5 volt,

$$\text{Error} = \frac{9.1 - 9.1}{9.1} \times 100\%$$

$$= 0\%$$

Precaution :

- All the components should be placed correctly.
- Reading of multimeter should be taken carefully.
- After the experiment, power supply should be switched off.

Discussion :

By observing the values, kircchoff's current law is verified. The errors are negligible which may have occured for the rounding error. Thus, the experiment is done successfully.

Reference :

B.L. Theraja and A.K. Theraja- "A textbook of Electrical Technology" volume- I

Experiment no : 04

Name of the experiment: Verification of superposition theorem.

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Experiment no.04

Name of the experiment: Verification of Superposition theorem.

Objective:

- To know about the application of superposition theorem.
- To verify superposition theorem.

Theory: The superposition theorem states that "In a network of linear resistances containing more than one generator, the current which will flow at that moment in that point is as if the each generators were considered for the time being separetly, will add up to the total voltage."

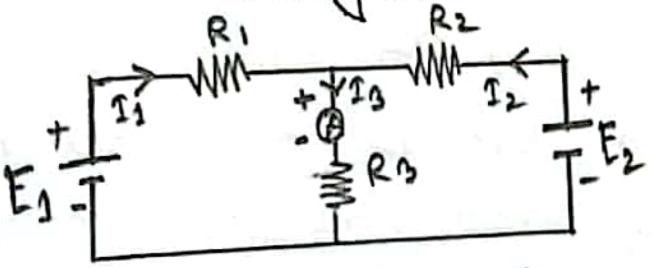

fig. with both supply

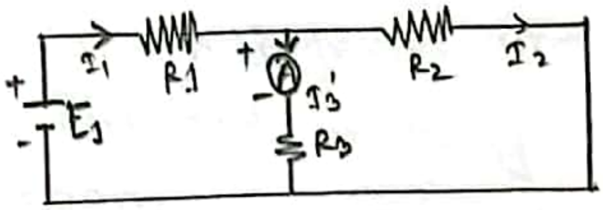

fig. with E1 active

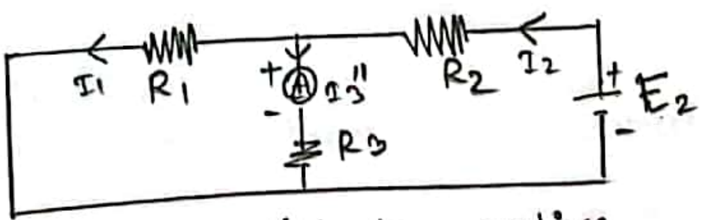

fig. with E2 active

Here, for the figure with both power supply.

$$I_3 = I_3' + I_3''$$

From Ohm's law we get,

$$V \propto I$$
$$\Rightarrow V = IR$$
$$\therefore I = \frac{V}{R}$$

when the resistance is in parallel, the equivalent resistance is,

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$$

when resistances are in series, the equivalent resistance is,

$$R_s = R_1 + R_2 + \cdots$$

The current divider rule states that," the current through any branch of a parallel resistive network is equal to the total resistance of the resistor in interest and multiplied by the total current entering the parallel configuration.

$$I_x = \frac{R_T}{R_x} \times I_t$$

In special case,
only for two resistors in a parallel circuit, it will be,

$$I_1 = \frac{R_2}{R_1+R_2} \times I_t \quad \text{and} \quad I_2 = \frac{R_1}{R_1+R_2} \times I_t$$

Working diagram:

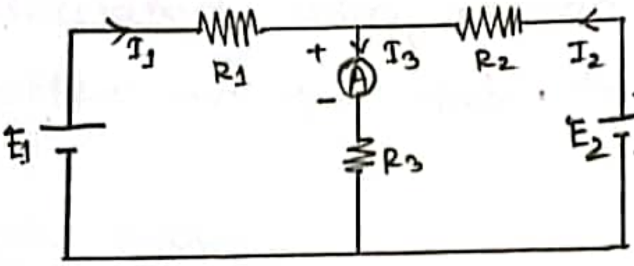

fig. (1)

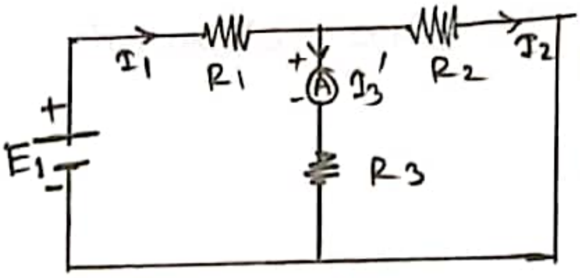

fig. (2)

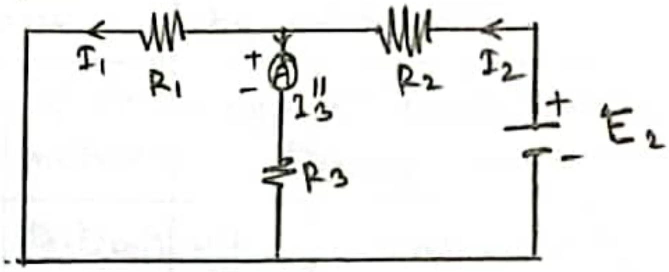

fig. (3)

Apparatus:

- Two power supplies
- Bread board, wire
- Multimeter
- Resistor

Procedure:

- connecting all the components according to the working diagram.
- The practical values of I_3 is measured by using ammeter and plotted in data table.
- Re-arranging the circuit, taking the value of I_3'.
- Again taking I_3'' while E_2 is active

• Then the values of I_3, I_3' and I_3'' were calculated using respective formula and plotted on the data table.

Data table:

E1 acts alone			E2 acts alone			Both act together	
observation	I_3' (mA) theory	I_3' (mA) practical	observation	I_3'' (mA) theory	I_3'' (mA) practical	I_3 theory $=I_3'+I_3''$	I_3 practical $=I_3'+I_3''$
01	8.8mA	9.0mA	01	2.3 mA	2.4mA	11.1mA	11.4 mA
02	1.16mA	1.05mA	02	2.12mA	2.02mA	3.28 mA	3.07mA
03	3.36mA	3.38mA	03	1.84mA	1.89 mA	5.2mA	5.27mA

For E_1,

$$I = \frac{E_1}{R_T} \quad , \quad I_3' = \frac{IR_2}{R_2+R_3}$$

For E_2, $I = \dfrac{E_2}{R_T}$, $I_3'' = \dfrac{IR_1}{R_1+R_3}$

Precaution:

• Ammeter should be connected in series with the circuit.

• The wire and components should be connected accurately.

• The temperature of Resistor should be checked.

• After the experiment, power supplies

should be ~~stiw~~ switched off.

Discussion:

The superposition theorem is verified by doing this experiment successfully. In this experiment, Ohm's law, current divider rule, equivalent resistance of series and parallel combination are used. It can be said that we have done the experiment successfully inspite of getting a small different between theoretical and practical values of current I_3 which is negligible.

Reference:

B.L. Theraja and A.K. Theraja - "A textbook of Electrical Technology" volume- I

Experiment no : 05

Name of the experiment : Determine the V-I characteristics of a PN junction diode.

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Experiment no. 05

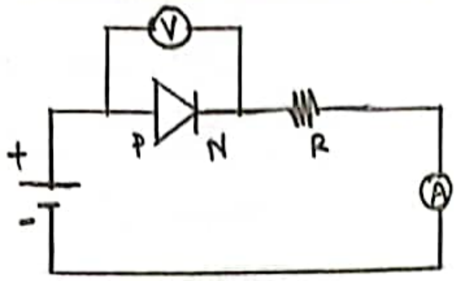
Name of the experiment: Determine the V-I characteristics of a PN junction diode.

Theory: "A semiconductor diode is a simple electrical device that allow the flow of current only in one direction. It is similar to a switch. It has p-type and n-type region. P-type forms a node and has an excess of holes whereas the N-type forms cathode and has excess of electrons.

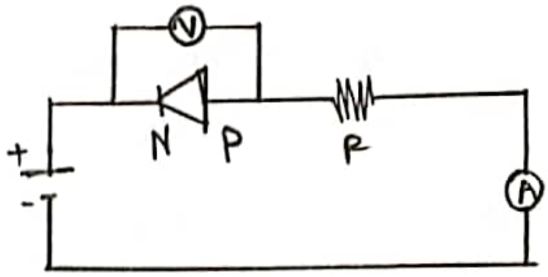
when the two region meet, the electrons fill the holes and there are no free electrons or holes. This region is called depletion region. when the battery polarity is forwarded, current will flow. This causes the holes to move forwards the depletion region and the free electrons too. The depletion region shrinks, allowing current to flow. Thus, a diode acts like a conductor during forward bias.

When the battary polarity is reversed, the holes move away the depletion region as the free electrons expanding the region. Thus, a diode acts like an insulator during reverse bias."

Working diagram:



Forward bias



Reverse bias

Apparatus:

- DC power supply and wire
- Digital multimeter
- Breadboard
- Resistor
- Diode

Procedure:

- Connecting all the components as shown in the working diagram.
- The forward voltage was increased from zero in suitable equal steps and the resulting current was recorded.
- Again the reverse voltage was increased from zero in suitable equal steps and the resulting current was recorded.
- The graph was plotted with the collected data.

Result :

Forward bias

0V → 0mA

0.3V → 0mA

0.47V → 0.1mA

0.52V → 0.4mA

0.61V → 2.1mA

0.69V → 11.2mA

0.7V → 16.5mA

Reverse bias

0.02V → 0.1 μA

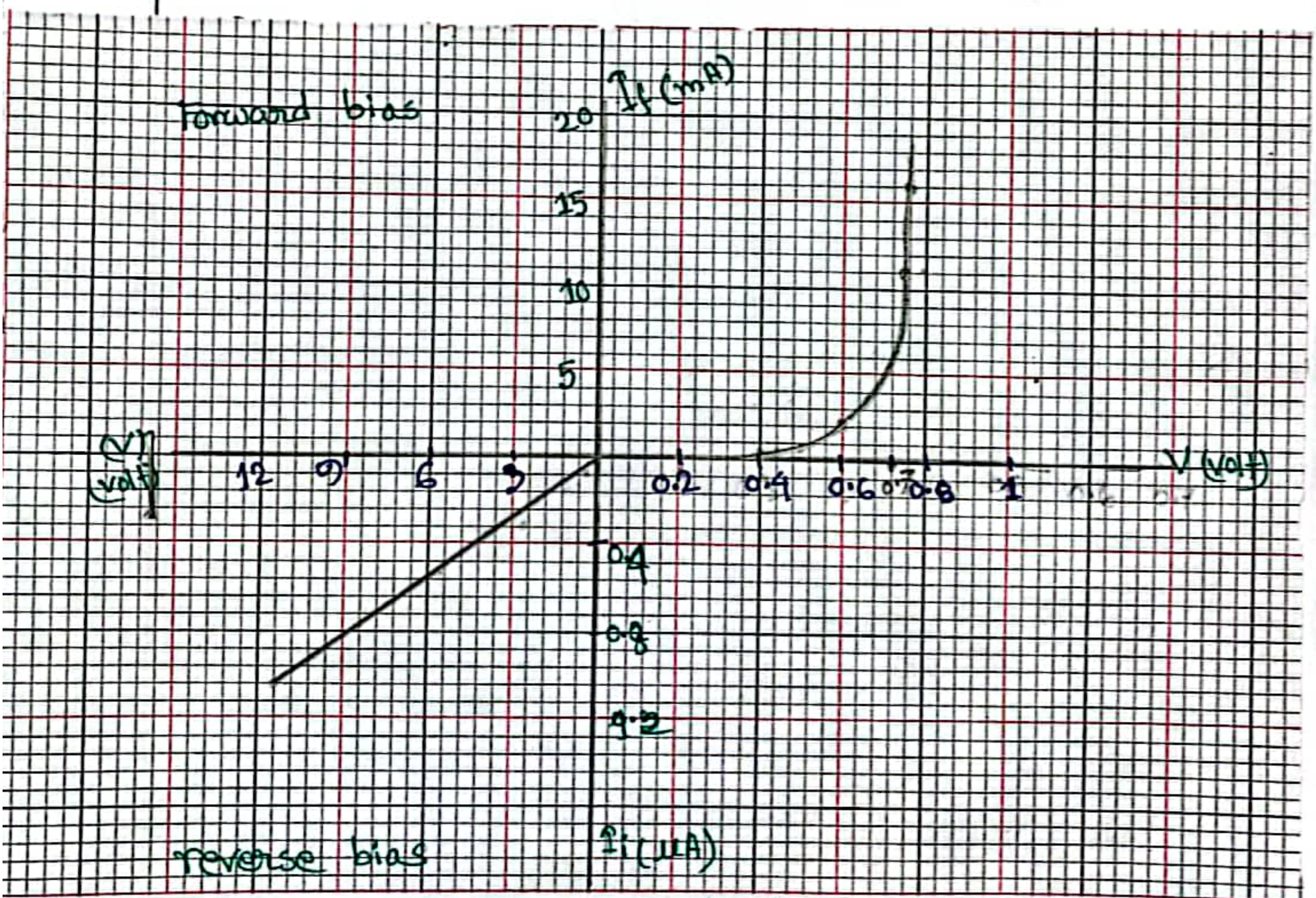
1.41V → 0.2 μA

2.6V → 0.3 μA

10V → 1.1 μA

Thus V-I characteristics of P-N diode is verified.

Graph:



PN Junction diode

Precaution:

- All the connections should be neat and clean.
- Power supply should be given carefully.
- Multimeter should have been in proper range.

Discussion:

The forward characteristics line is not straight i.e. the diode doesn't obey ohm's law. when the F.B. voltage V_F is less than internal potential difference V_0, flows current I_F is zero. when V_F becomes greater than V_0, small current flows. As V_F is further increased, the current flows very rapidly. During the reverse voltage, as V_R is increas from zero, I_R increases and reaches its maximum value I_0 at a small value of V_R. when V_R is further increased, the I_R is almost independent of the magnitude and it called leakage current. when the V_R is increased beyond critical value, I_R increas very rapidly and the diode reaches breakdown.

Experiment no : 06

Name of the experiment: Determine the V-I characteristics of a zener diode.

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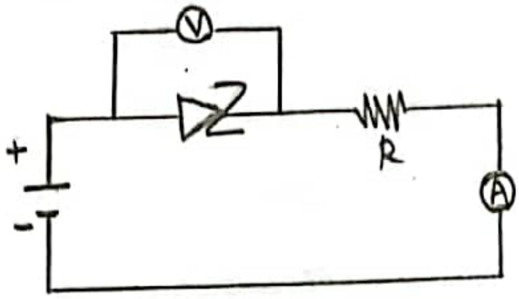
Experiment no. 06

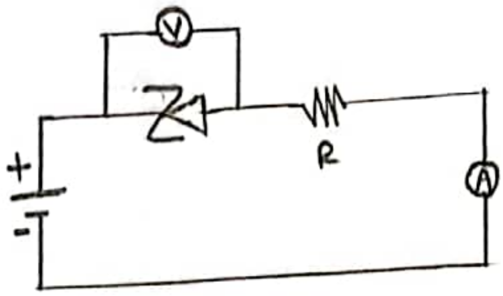
Name of the experiment: Determine the V-I characteristics of a zener diode.

Theory: "A properly doped crystal diode which has a sharp breakdown voltage is known as a zener diode. It is like an ordinary diode except that it is properly doped so as to have a sharp breakdown voltage. It is in always reverse biased. It has sharp breakdown voltage V_z. When forward bias, its characteristics are just those of ordinary diode. It is not burnt immediately just because it has entered the breakdown region. As long as the external circuit connected to the diode limits the diode current to less than burn out value, the diode will not burn out."

Working diagram:



Forward Bias



Reverse Bias

Apparatus :

- DC power supply and wire
- Resistor and multimeter
- Zener diode
- Bread board

procedure:

- Connecting all the components as shown in the working diagram.
- The forward voltage was increased from zero in suitable equal steps and the results were recorded.
- Again increasing reverse voltage from zero in suitable equal steps and the results were recorded.
- The graph was plotted with the collected data.

Result :

Forward bias

0V → 0 mA

0·65V → 0·1 mA

0·67V → 0·3 mA

0·69V → 0·6 mA

0·7V → 17·1 mA

Reverse bias

0V → 0 mA

0·7V → 0 mA

5.06V → 0·1 mA

5.26V → 0·4 mA

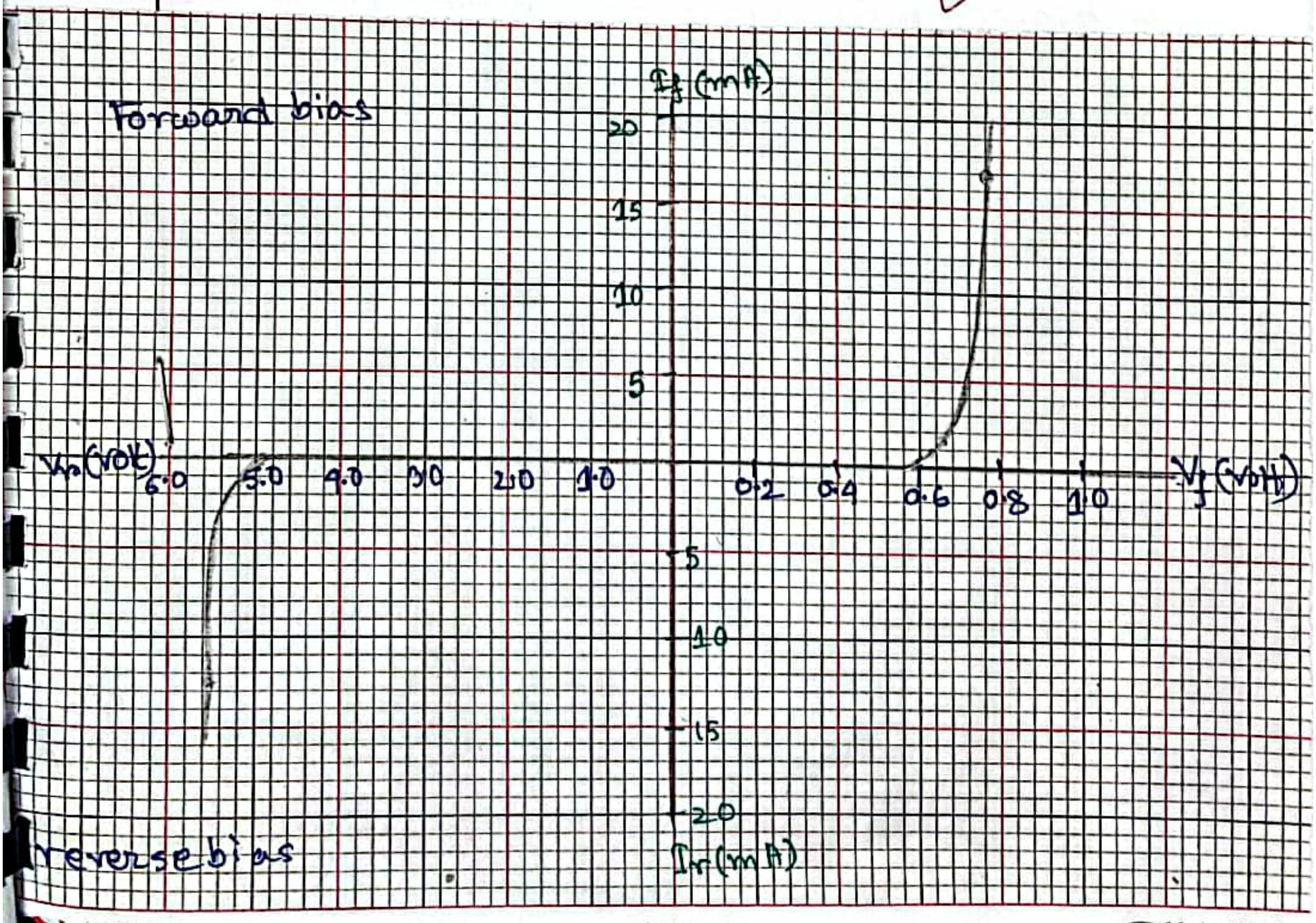
5.2V → 0·8 mA

5·3V → 2·9 mA

5·3V → 12·3 mA

Thus the V-I characteristics of a zener diode is verified.

Graph:



zener diode

Precaution :

- All the connections should be neat and clean.
- power supply should be given carefully.
- Multimeter should have been in proper range.

Discussion :

We have to use a resistor with the zener diode so that we can get the data easily. zener diode flows current safely in reverse bias and rapidly rise current in forward bias. According to the theory, by using the resulting current we have got a perfect V-I characteristics graph of a zener diode.