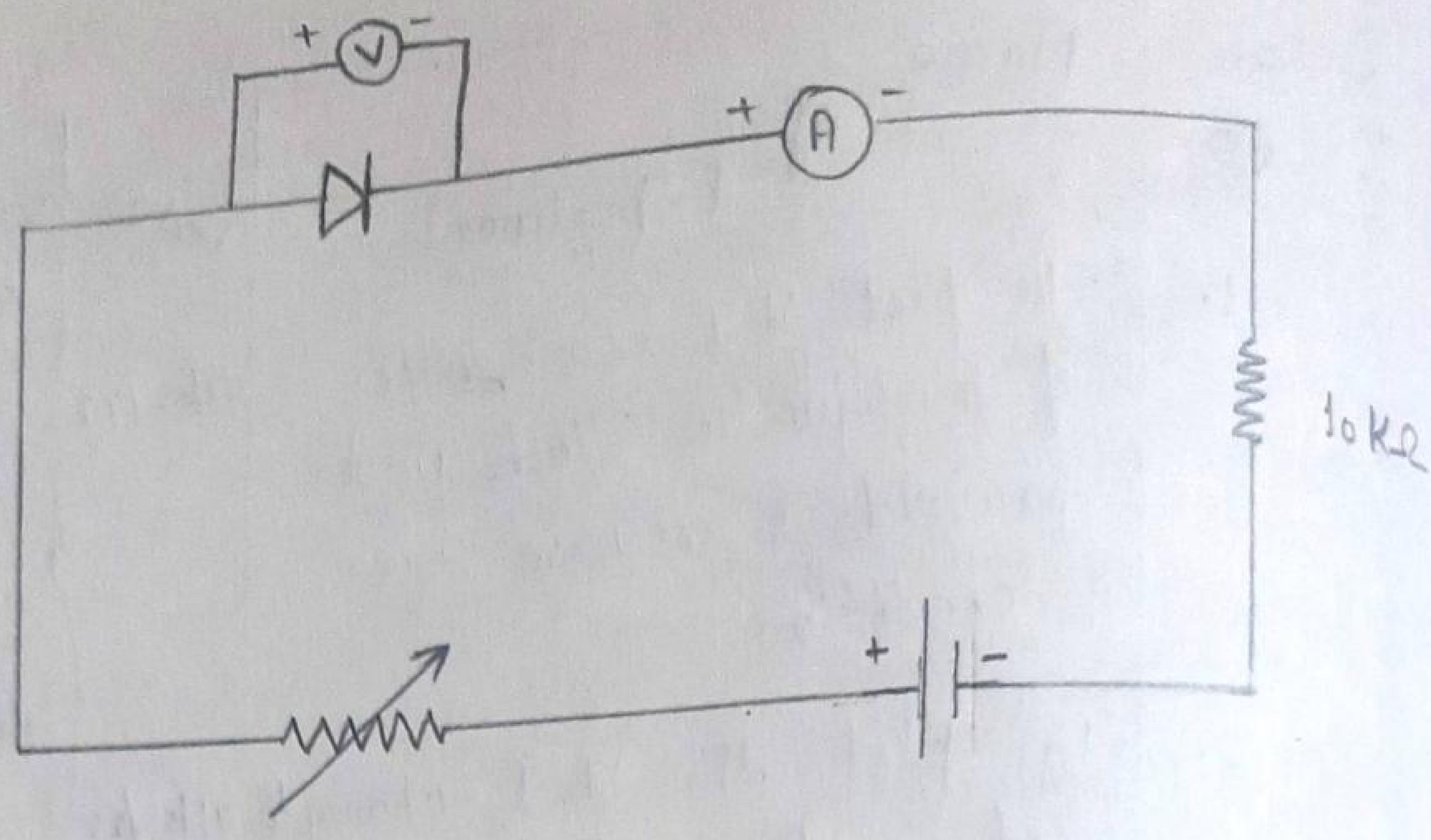
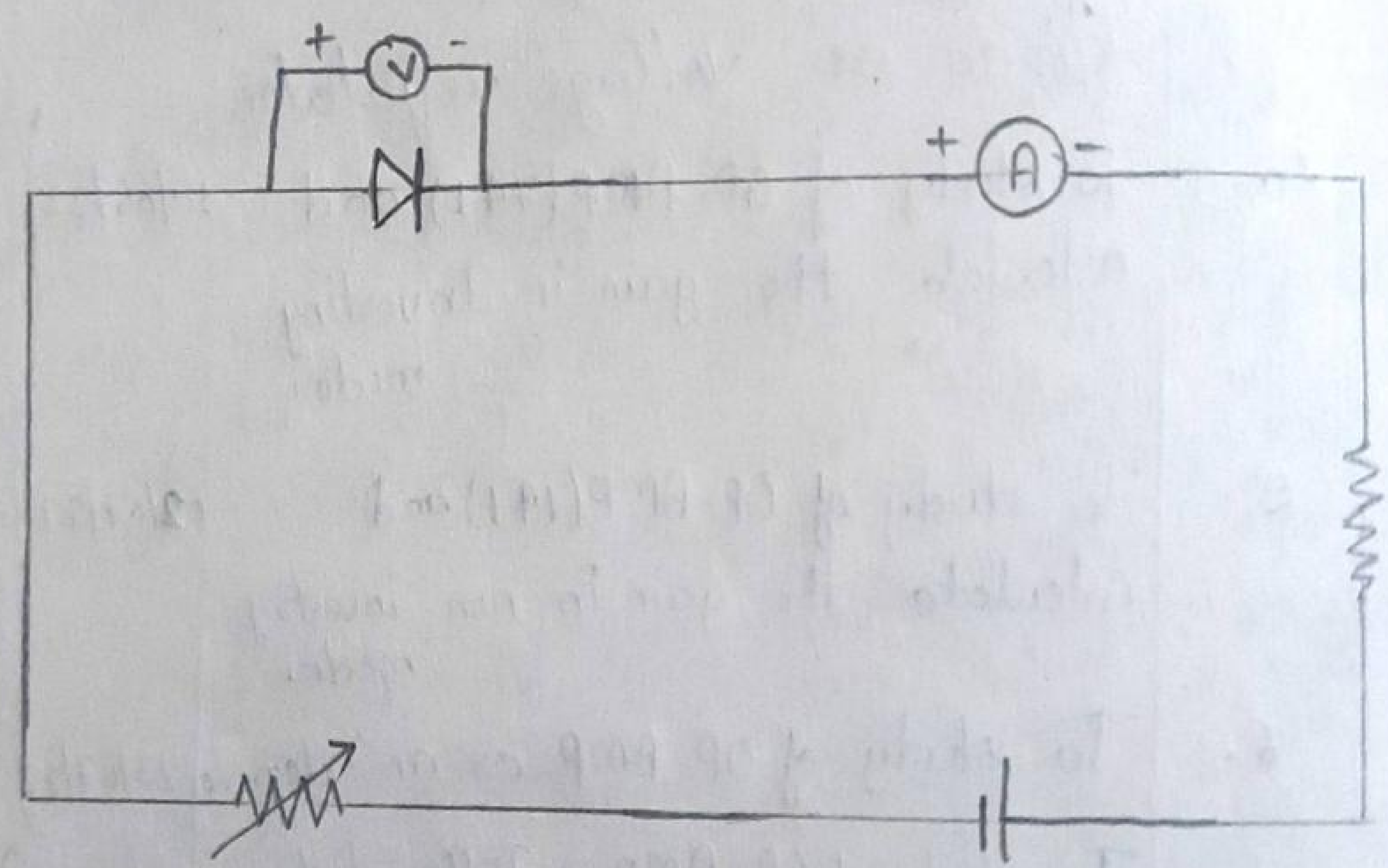


Forward Bias



Reverse Biased

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Experiment No. - 01

Object :- To plot the V-I characterstics of p-n junction diode under forward and reverse bias condition.

Apparatus Used :- p-n junction diode, voltmeter Ammeter, power supply

1. Zero External Voltage :-

When the external voltage is zero i.e. circuit is open, the potential barrier is at junction doesn't permit circuit current is zero.

2. Forward Biased :-

The potential barrier depletion region is reduced by applying forward biased resulting in heavy majority flow accross the junction.

3. p-n Junction Diode :-

A p-n junction diode is a two terminal or two electrode semi-conductor device which is formed when p-type and n-type extrinisic semi-conductors are joined. It allows current flow in one direction only.

4. Reversed Biased :-
In reverse biasing, negative terminal of diode is connected to positive of battery and positive of diode is connected to negative of battery. The current flowing in this condition is called leakage current.

5. Knee Current :-
Knee voltage is defined as max. voltage applied to a p-n junction diode in forward biased region for which the diode starts conducting and the corresponding current is called knee current.

Observation Table :-

Forward Biased		Reversed Biased	
Voltage (V)	I (mA)	Voltage (V)	I (μA)
0.38	0.00	0.11	0.00
0.42	0.00	0.62	0.00
0.55	1.00	1.00	0.10
0.59	1.50	1.70	0.20
0.61	3.00	2.50	0.30
0.68	5.10	3.10	0.30
0.70	6.30	4.00	0.50
0.76	11.20	4.50	0.60
0.80	15.30	4.50	0.70

Calculation :-

$$\% \text{ error} = \left(\frac{0.7 - 0.68}{0.7}\right) \times 100 = 2.85\%$$

Result :-

The V-I characteristics of p-n junction in reverse and forward bias has been verified.

Precaution :-

While doing the experiment do not exceed the rating of the diode.

Connect voltmeter and ammeter in correct polarity as shown in circuit diagram.

Don't switch on the power supply unless you have checked the circuit connection as per the circuit diagram.

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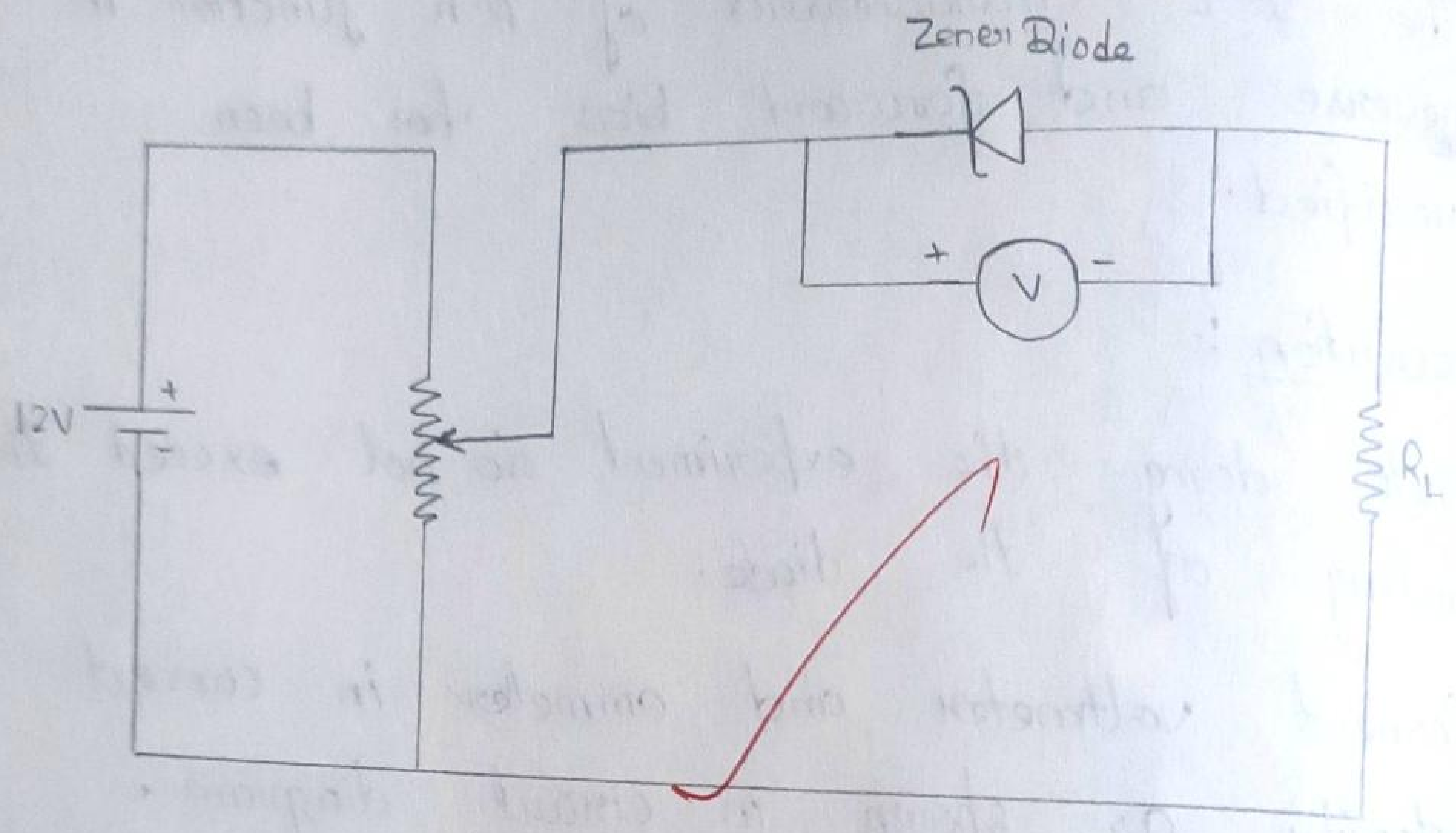


Circuit diagram of Zener Diode
Under Reverse Biasing

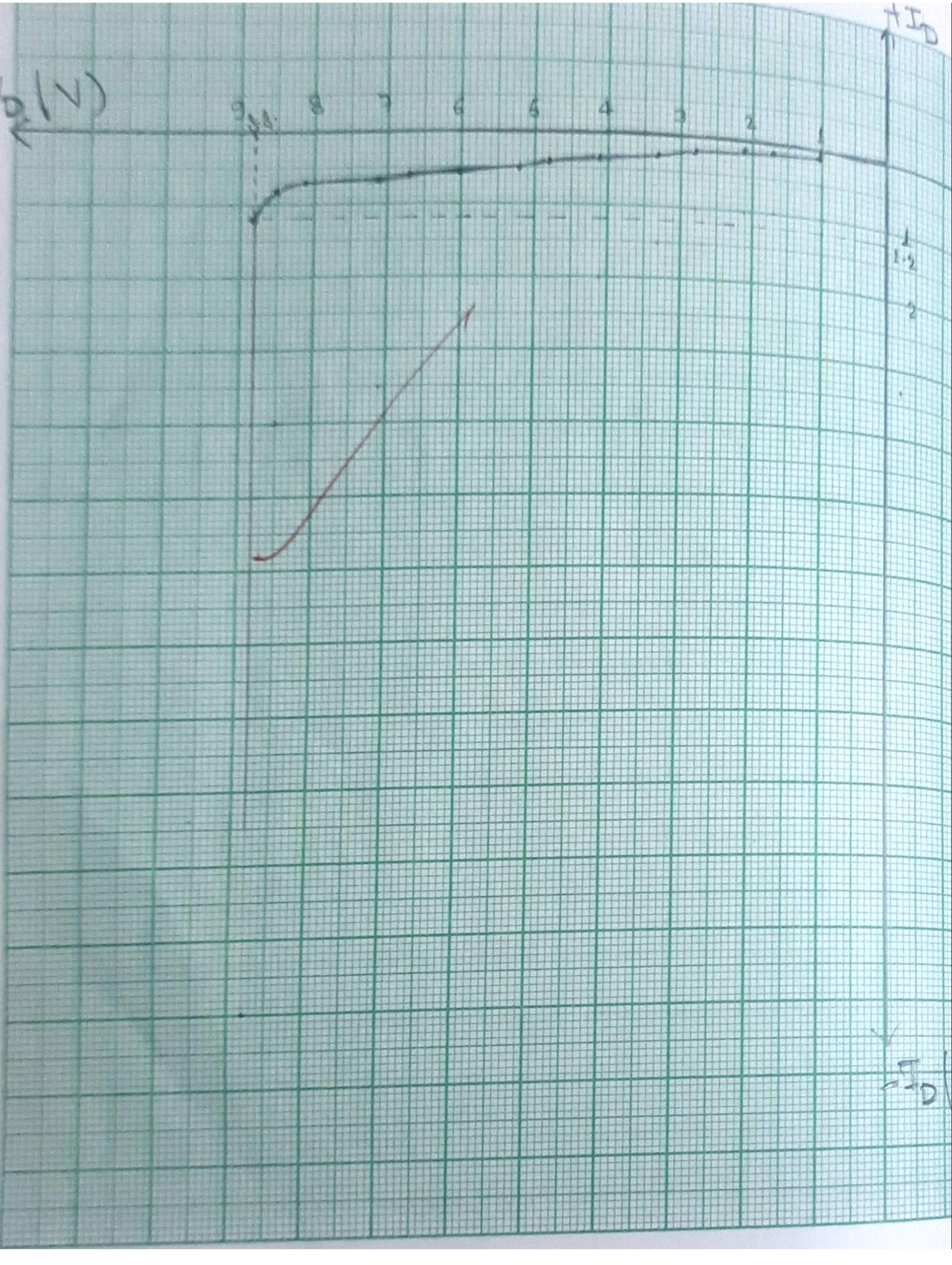
Experiment no- 02

Object :- To plot the V-I characterstics of zener diode.

Apparatus Used :-

Zener diode
Resistor
Bread Board
Power Supply
Connecting leads

Theory :- When both sides of junction are heavily doped, depeletion region is narrow. In such a case, electric field become higher as 10^7 V/m in the depeletion region. In this process, it become possible for some electrons to jump across barrier from valence band from p-type semiconductor to some of untill conduction band in n-type semiconductor. Especially designed Si-diode is optional to operate in breakdown region. It is specified by zener diode (V_z) and maxed noted current.



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Observation Table :-

S.No.	Reverse Biased	
	V_D	I_D
1.	1.0	0.1
2.	1.7	0.1
3.	2.1	0.1
4.	2.2	0.2
5.	2.8	0.2
6.	3.3	0.3
7.	4.1	0.4
8.	4.8	0.4
9.	5.2	0.5
10.	6.0	0.6
11.	6.7	0.6
12.	7.1	0.7
13.	8.1	0.7
14.	8.5	0.8
15.	8.8	1.2

Result :- Based on observation $V_D - I_D$ characteristicks of Zener diode curve has been plotted.
From $V_D - I_D$ characteristics, we get
$V_z = 1.5$ volt

Precaution

- All connection should be tight.
- The current limiting resistance should be 1 KΩ or more.

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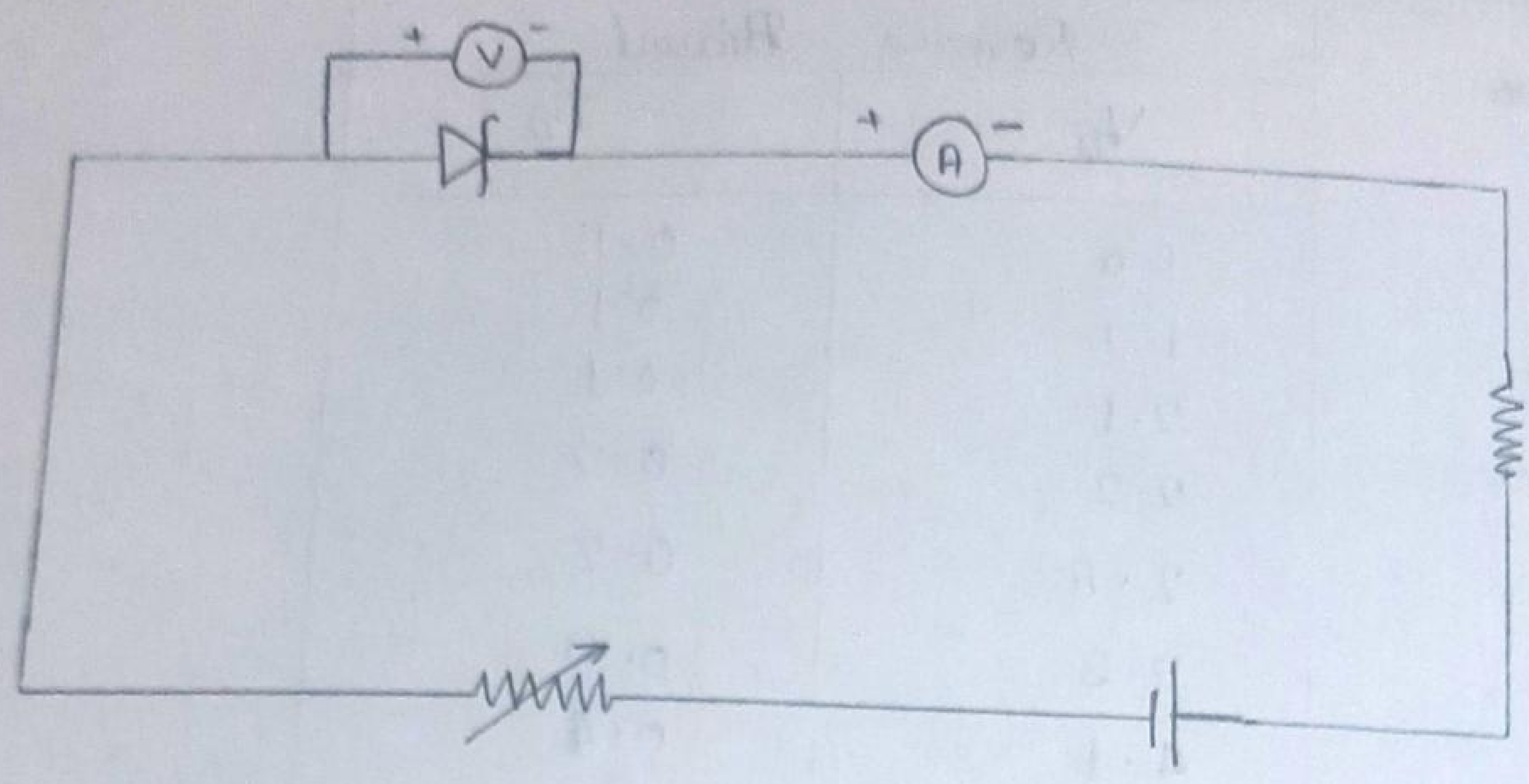

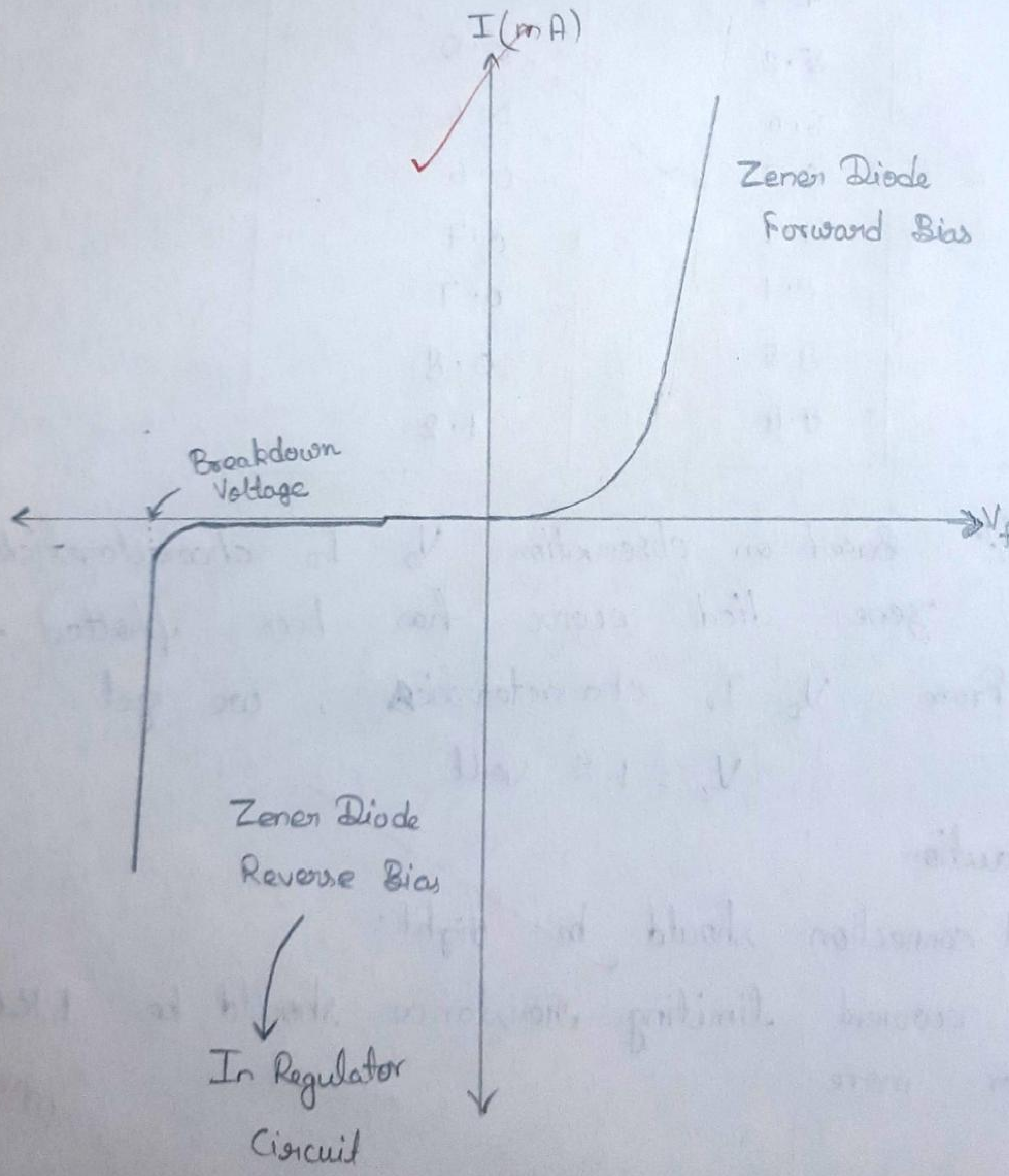

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Experiment no--03

Object :- Study and Plot the characterstics of zener diode or voltage regulator.

Apparatus Used :-

Zener diode
Resistor
Rheostate
Voltmeter
Ammeter
Connecting Wires
Bread Board

Theory :- Zener diode is constructed for operation in the reverse breakdown region from V-I characterstics curve. We can study that the zener diode has a region in its reversed biased characterstics of almost a constant negative voltage regardless of the value of current flowing through the diode and remains nearly constant with large changes in current as long as the zener diode current remains between the breakdown current max. current. This ability to control itself can be used to great effect to regulate or stabilize a voltage source against supply or load variation. Therefore, it is known as voltage-regulation.

TUTORIAL / PRACTICAL No.

Observation Table :

S.No.	V (volts)	I (μA)
1.	0.19	0.20
2.	0.42	0.30
3.	1.20	0.40
4.	1.90	0.40
5.	2.50	0.50
6.	4.00	0.60
7.	4.60	0.60
8.	6.00	0.80
9.	6.50	0.80
10.	7.30	1.00
11.	8.20	1.00
12.	8.80	74.00

Result : Breakdown potential also called zener potential i.e. $V_z = 8.8\ V$

Precautions :

- While doing the experiment do not exceed the rating of the diode.
- Connect voltmeter & ammeter in current polarimeter.
- Do not switch on the power unless you have checked the connection of the circuit.

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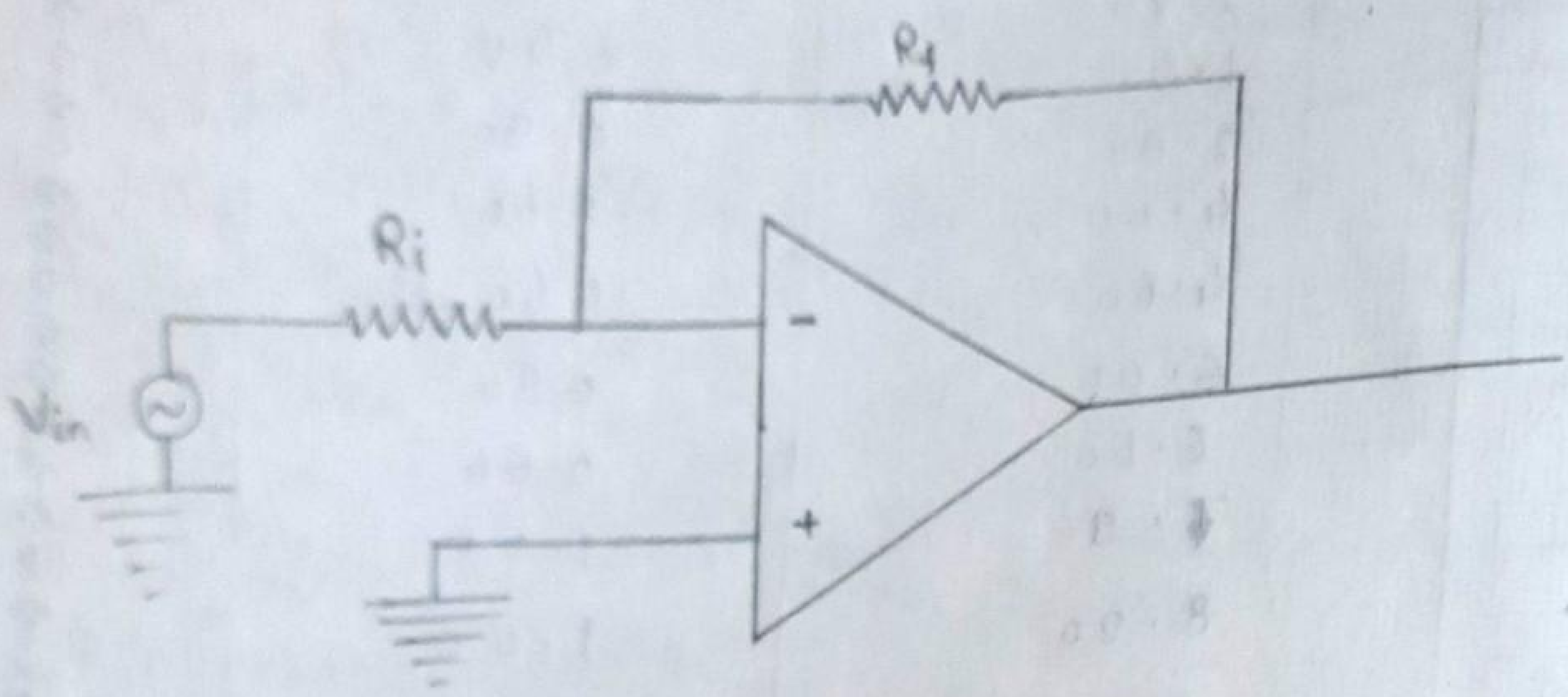


Fig: Inverting OP-AMP

Experiment no. - 4

Object :- To study of OP-AMP (741) and calculate the gain in Inverting Mode.

Apparatus Used :- OP-AMP trainer kit
Digital Multimeter
Variable Power Supply

Theory :- An inverting amplifier or inverting voltage controlled voltage source is a closed loop amplifier in which the input is applied at the inverting terminal. The ouput of inverting amplifier is out of phase by 180° with respect to input.

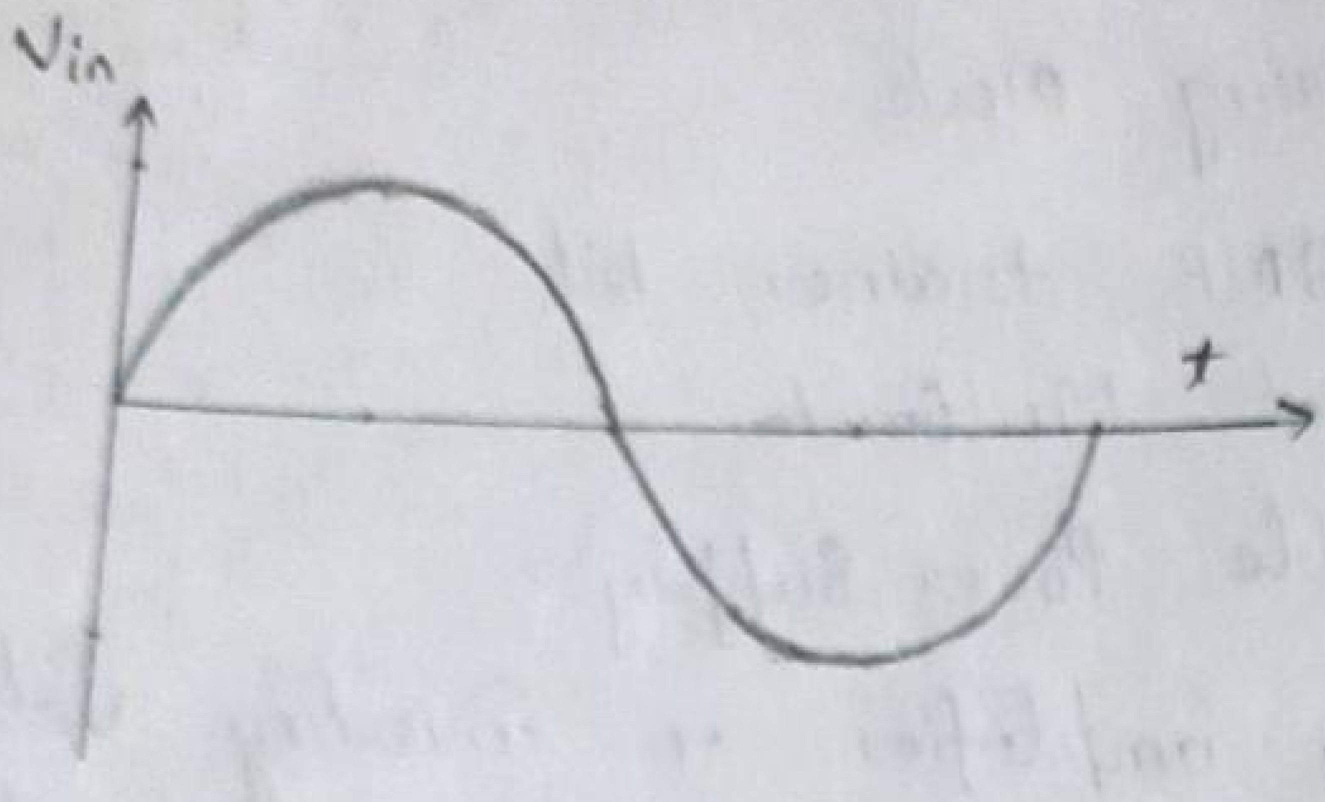
Assuming that the OP-AMP is ideal and it is processing some output, then open loop gain will be infinite.

For an OP-Amp, we know that -

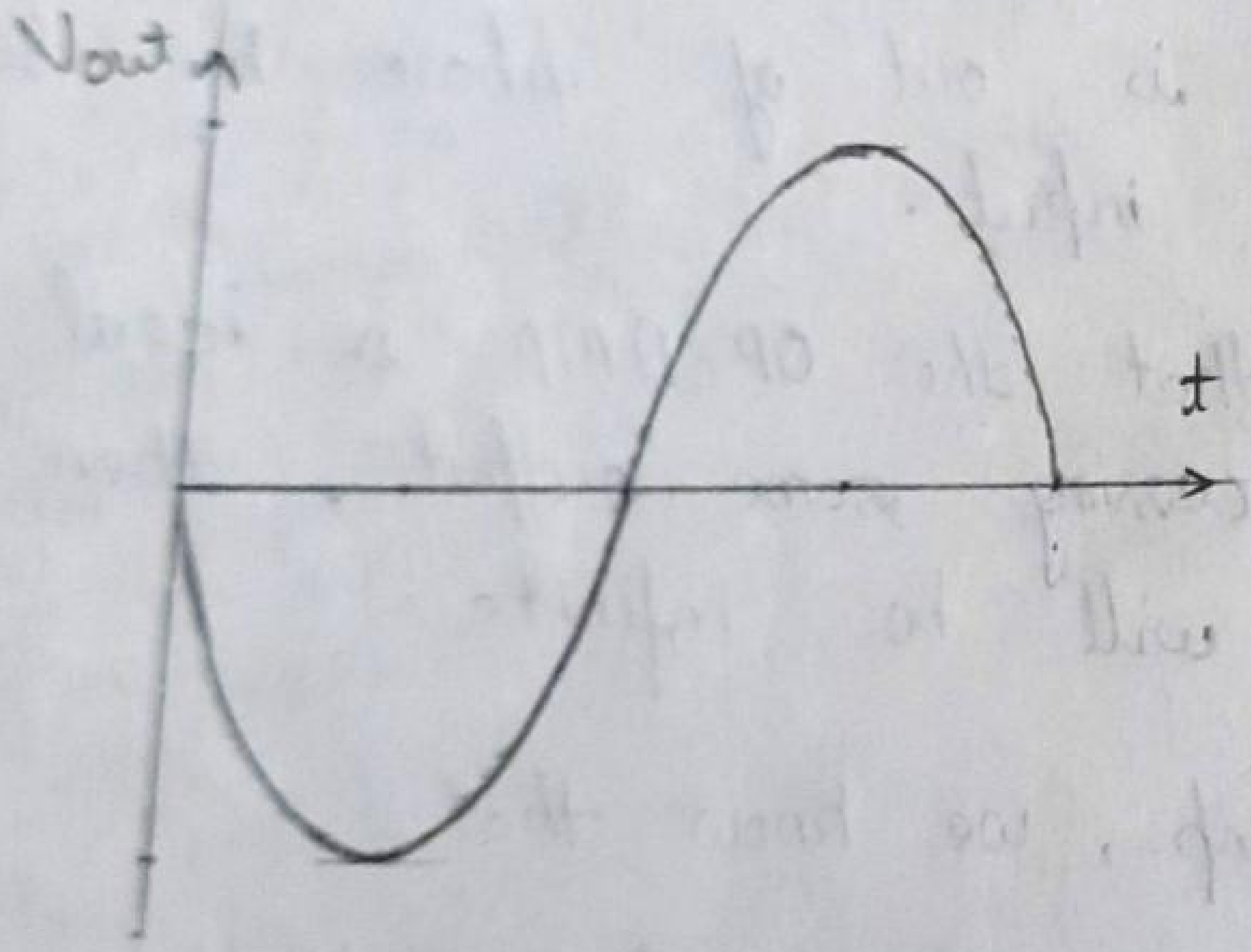
$$\text{Gain } A = \frac{V_{out}}{V_{inp}} = \frac{-R_f}{R_i} \qquad (V_{id} = V_1 - V_2)$$

$$\frac{V_0}{V_i} = \frac{-R_f}{R_i}$$

$$\Rightarrow \boxed{V_o = V_i\left(\frac{-R_f}{R_1}\right)}$$



Input Signal



Output Signal

Observation Table :-

S.No.	Vin (V)	Vout (V)	Gain $A = \frac{V_o}{V_{in}}$
1.	-4	40	-10
2.	-2	20	-10
3.	0	0	0
4.	2	-20	-10
5.	4	-40	-10
6.	6	-60	-10
7.	8	-80	-10
8.	10	-100	-10
			Avg. Gain A = 10

$R_i = 5\ K\Omega$

$R_f = 50\ K\Omega$

Result :- Inverting Operation has been performed by using OP-Amp which have Gain equals to 10.

Precautions :-

1. The circuit should be connected tightly.
2. Take the reading carefully.
3. Don't touch the naked wire.
4. Input and Output impedance should be within suitable range.

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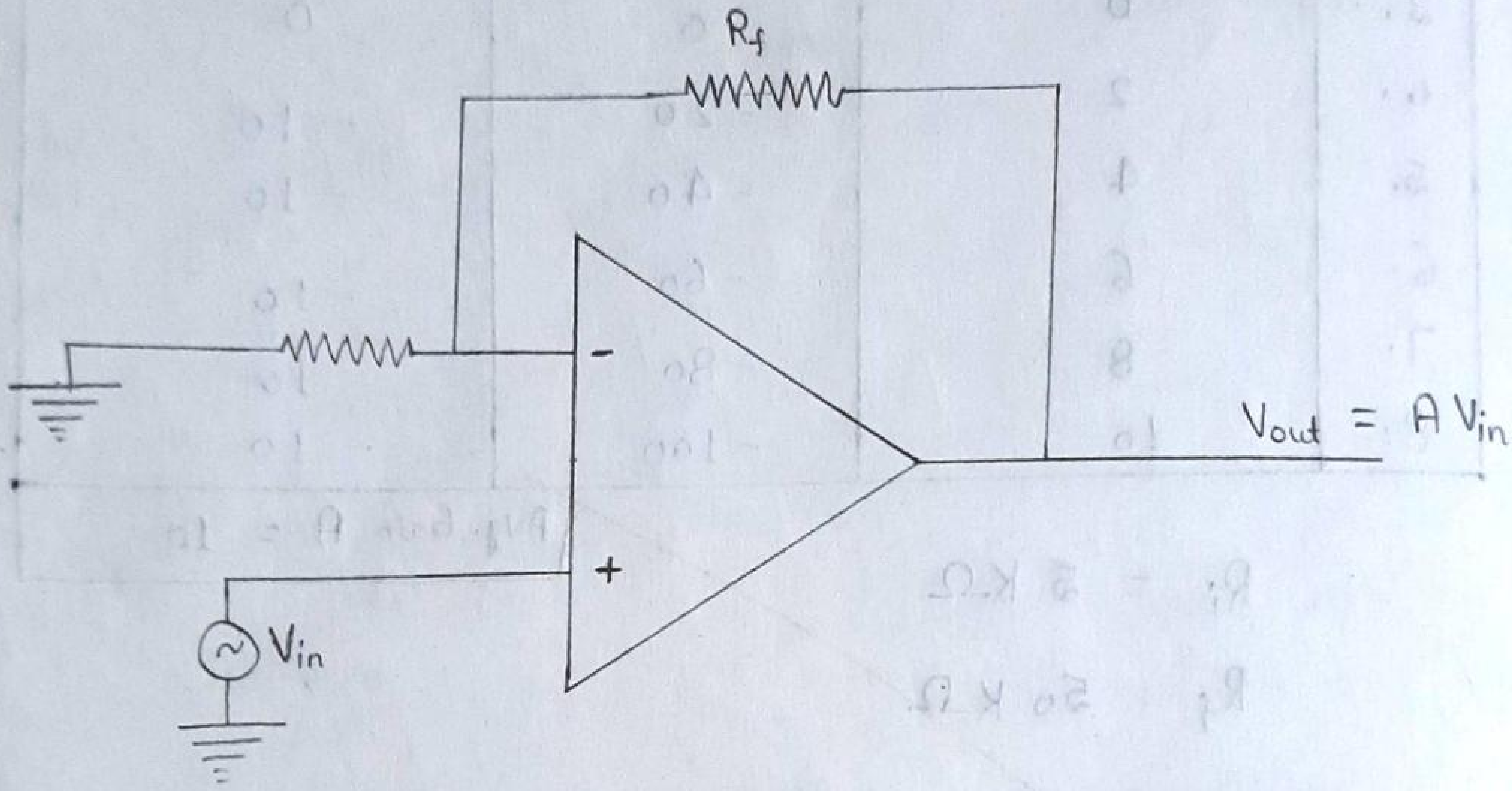

Fig :- Non - Inverting OP- AMP

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Experiment no. - 5

Object :- To study of OP-Amp (741) and calculate the gain in Non-inverting mode.

Apparatus Used :- OP-Amp trainer kit
Digital multimeter
Variable Power Supply

Theory :- In close loop non-inverting amplifier the external input signal is applied at the non-inverting terminal and inverting terminal is grounded.

The output of non-inverting amplifier is in phase with the input signal.

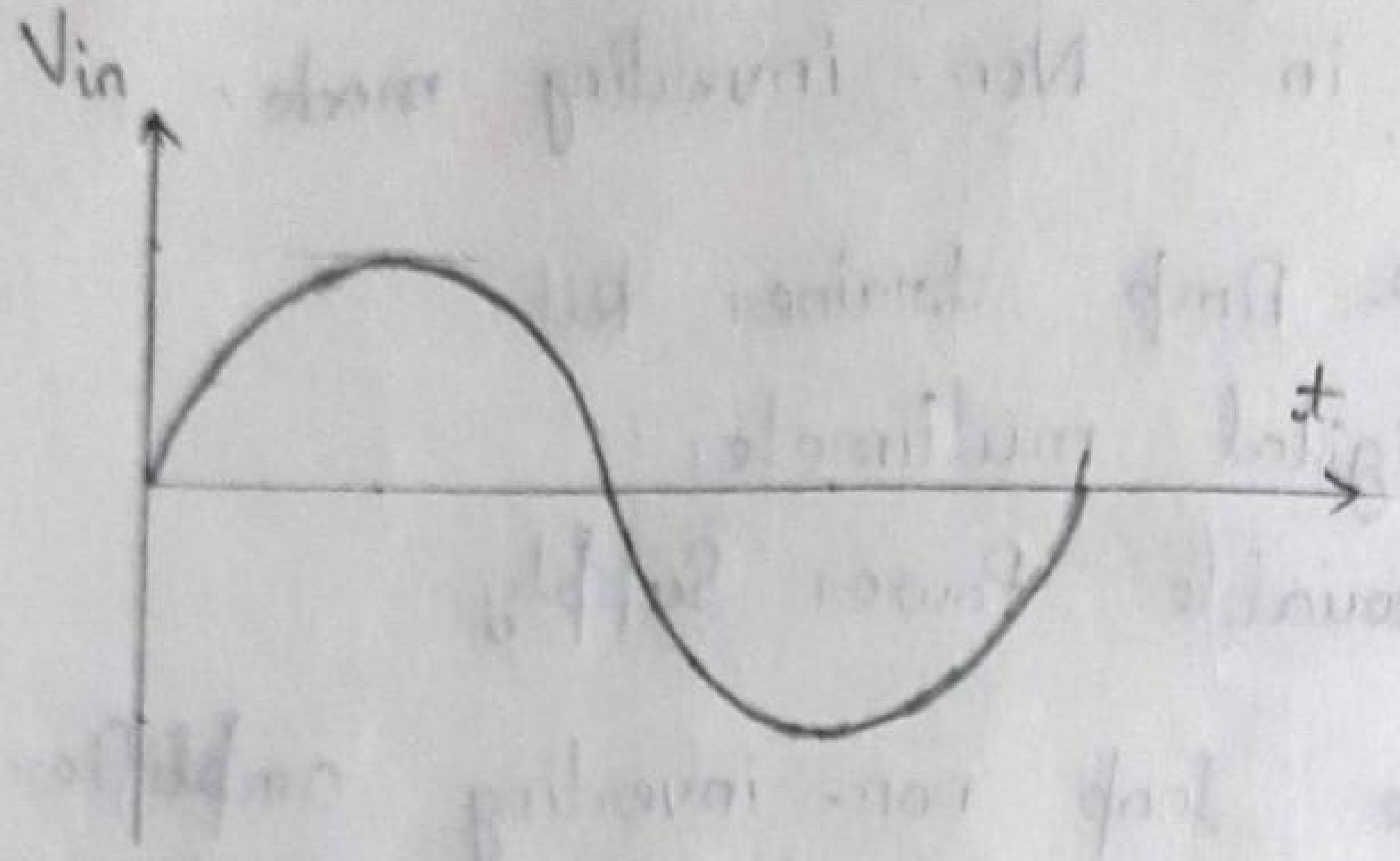
For an OP-Amp, we know that -
(in Non-inverting mode)

$$\text{Gain } A = \frac{V_{out}}{V_{inp}} = \left(1 + \frac{R_f}{R_i}\right)$$

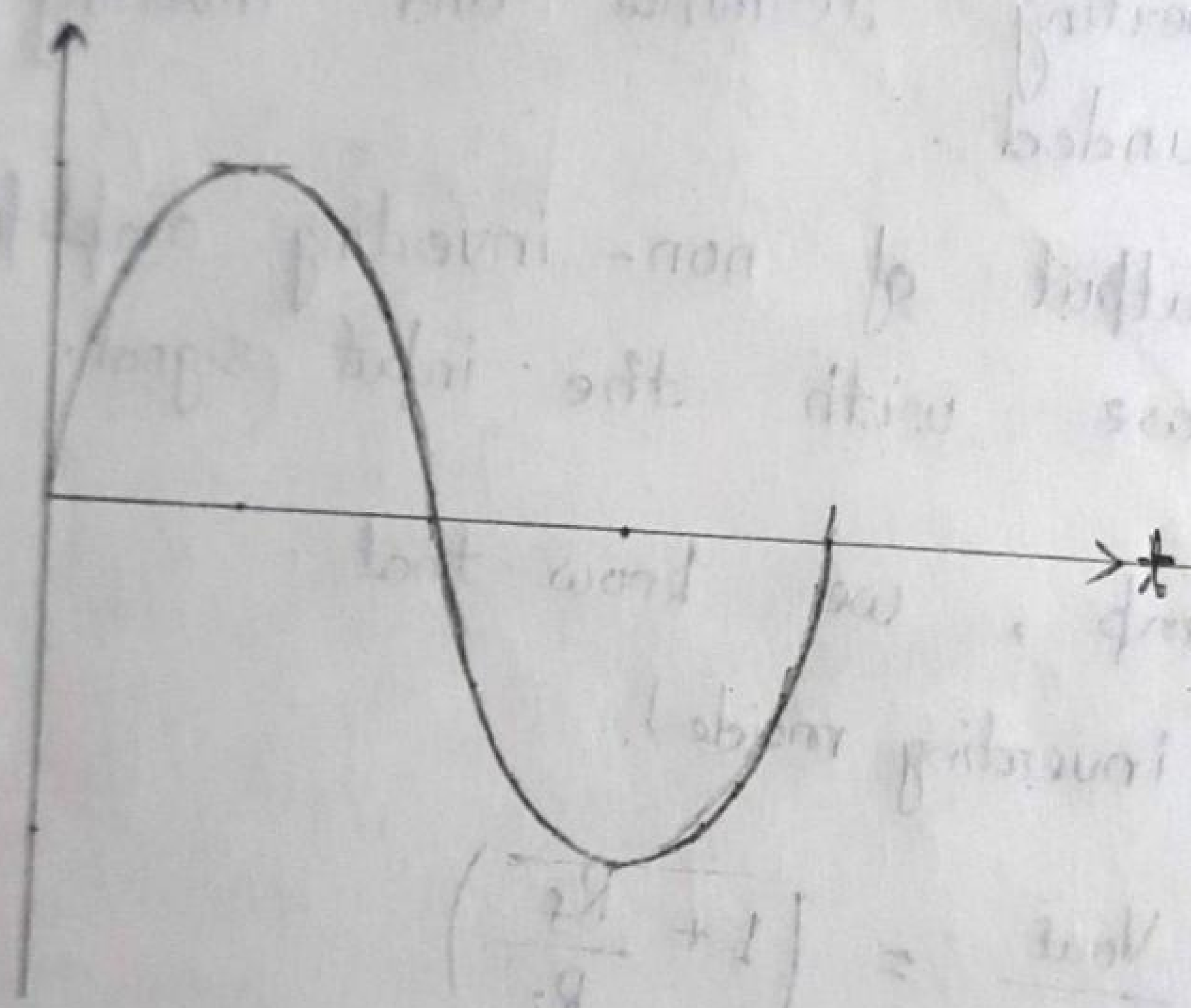
$$\Rightarrow \boxed{V_{out} = V_{in}\left(1 + \frac{R_f}{R_i}\right)}$$

- if $R_f = R_i$

$$\left[V_{out} = 2V_{in}\right]$$



Input Signal



Output signal

Observation Table :-

S. No.	$V_{in}(V)$	$V_{out}(V)$	Gain (A) = $\frac{V_o}{V_i}$
1.	-4	-36	9
2.	-2	-18	9
3.	0	0	0
4.	2	18	9
5.	4	36	9
6.	6	54	9
7.	8	72	9
8.	10	90	9

$R_i = 5\ K\Omega$

$R_f = 40\ K\Omega$

Gain $A = 9$

Result :- Non-inverting operation has been performed with non-inverting gain equals to 9.

Precautions :-

1. The circuit should be connected tightly.
2. Take the reading carefully.
3. Don't touch the naked wire.

prince

Observation Table :-

S. No.	V_{in}(V)	V_{out}(V)	Gain (A) = $\frac{V_o}{V_i}$
1.	-4	-36	9
2.	-2	-18	9
3.	0	0	0
4.	2	18	9
5.	4	36	9
6.	6	54	9
7.	8	72	9
8.	10	90	9

R_i = 5 KΩ

R_f = 40 KΩ

Gain A = 9

Result :- Non - inverting operation has been performed with non- inverting gain equals to 9 .

Precautions :-

1. The circuit should be connected tightly.
2. Take the reading carefully.
3. Don't touch the naked wire.

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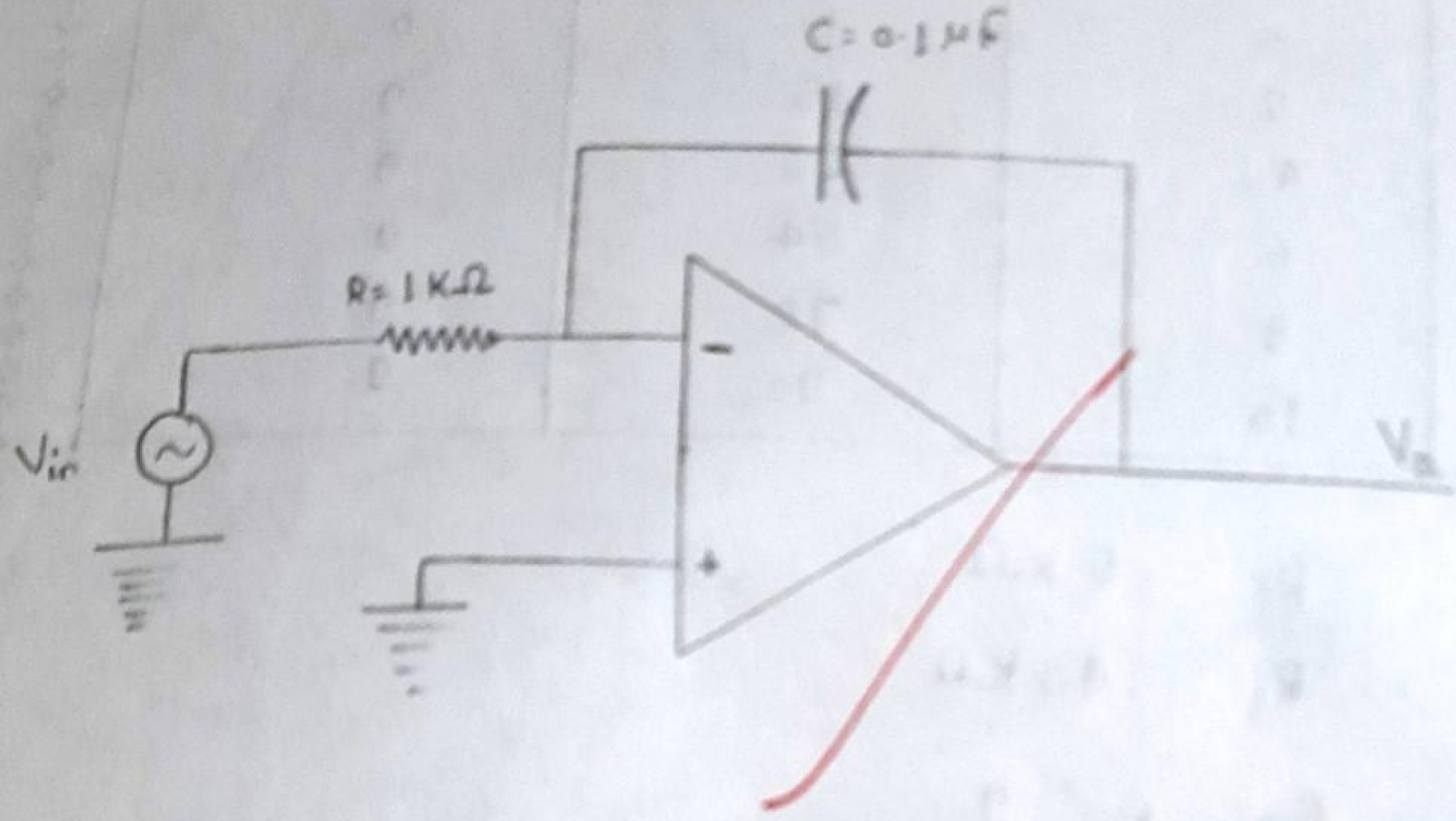


OP-AMP Integrator Circuit

$$\boxed{V_o = -\frac{1}{RC}\int V_{in}\,dt}$$

RC - Time Constant

Experiment no. - 6

Object :- To study OP-AMP as an Integrator.

Apparatus Used :- Circuit system, Resistance $R = 1 K\Omega$
Capacitance $C = 0.1 \mu F$
Connecting wires

Theory :-

OP- Amp Integrated Circuit :- It is an operational amplifier circuit that performs mathematical operation of Integration.

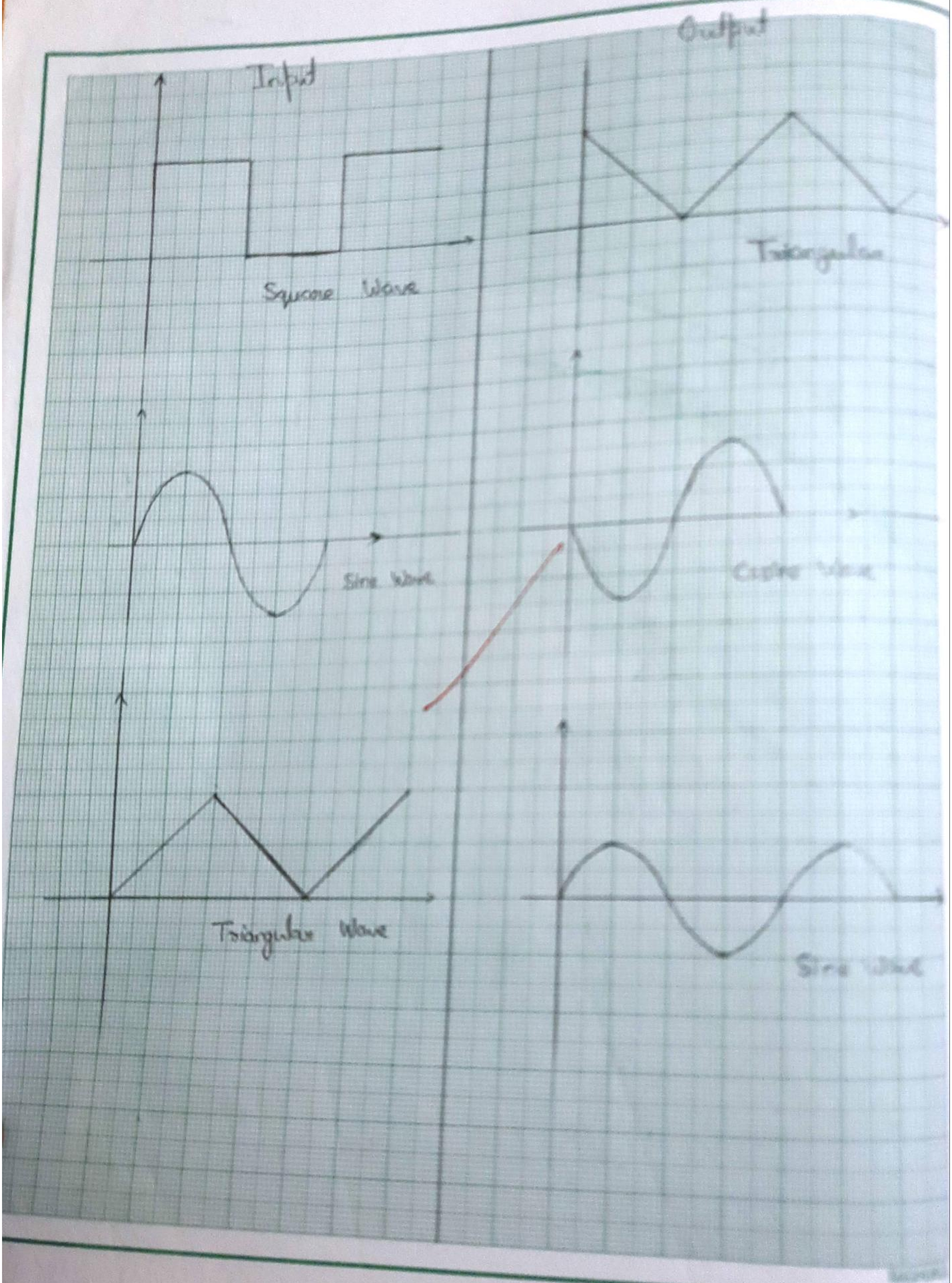
We varies the output of the respond to change in the input over time as OP- Amp Integrator produce an output voltage which is proportional to the integral of the integral of the input signal.

The Input Voltages are :

1. Square Wave
2. ~~Squ~~ Sine Wave

The corresponding Output Voltages are :-

1. Triangular
2. Cosine Wave


Input
Output
Square Wave
Triangular
Sine Wave
Cosine Wave
Triangular Wave
Sine Wave

Observations :-

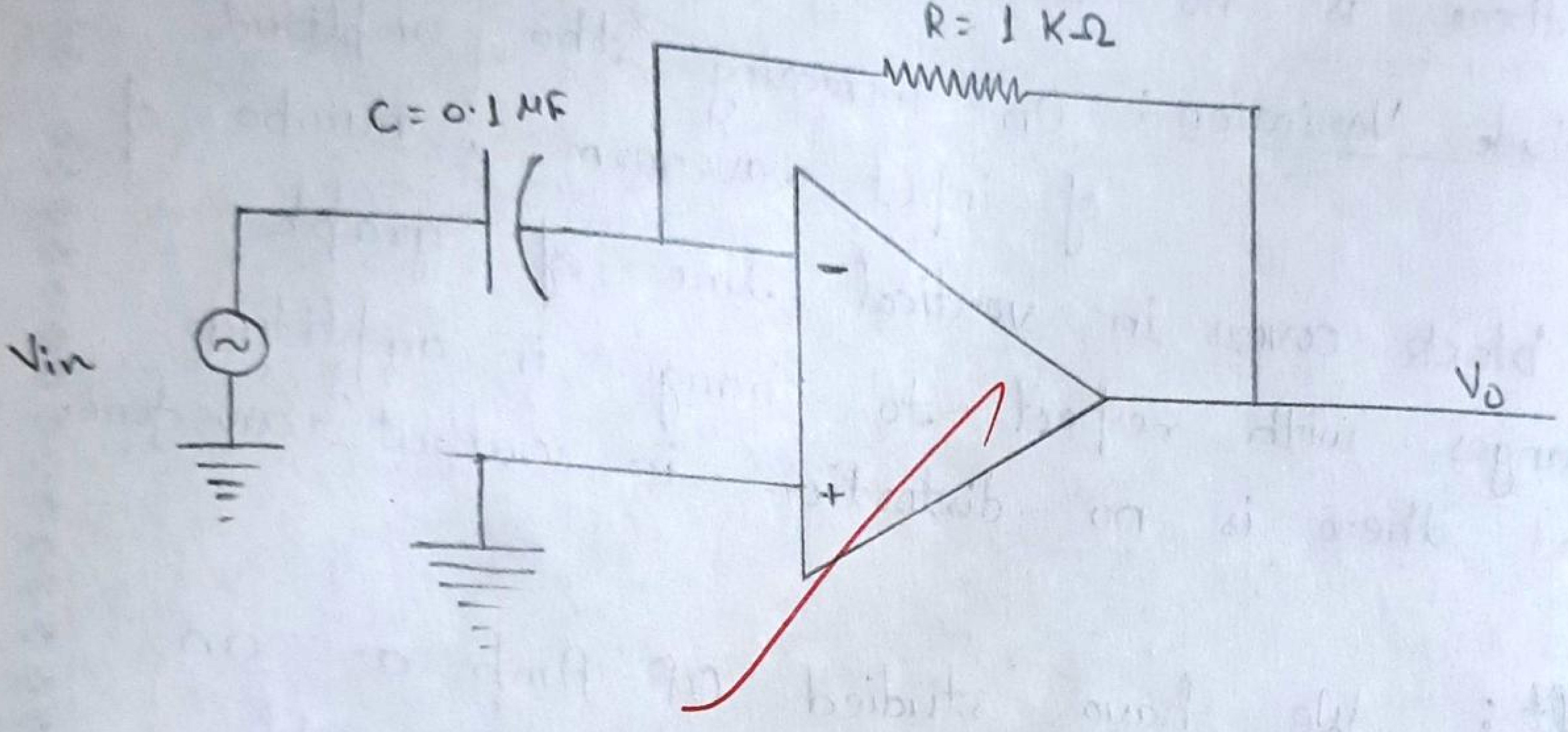
- Frequency Variation :- On increasing the frequency of input waveforms, number of cycles in output waveform increases and there is no distortion in output waveform.
- Amplitude Variation :- On increasing the amplitude of input waveform, number of block covers in vertical line of graph changes with respect to change in amplitude and there is no distortion in output waveform.

Result :- We have studied OP-Amp as an Integrator and plotted the graph.

Precautions :-

1. Check the connections before starting experiment.
2. All connections should be tight.
3. Amplitude and frequency should varyied within the range of instruments.

prince



OP-AMP Differentiator Circuit

$$\boxed{V_o = -RC\frac{d}{dt}(V_{in})}$$

Experiment no. - 7

Object :- To study OP-Amp as Differentiator.

Apparatus Used :- Circuit System, Connecting wires
Resistance R = 1 KΩ
Capacitance C = 0.1 μF

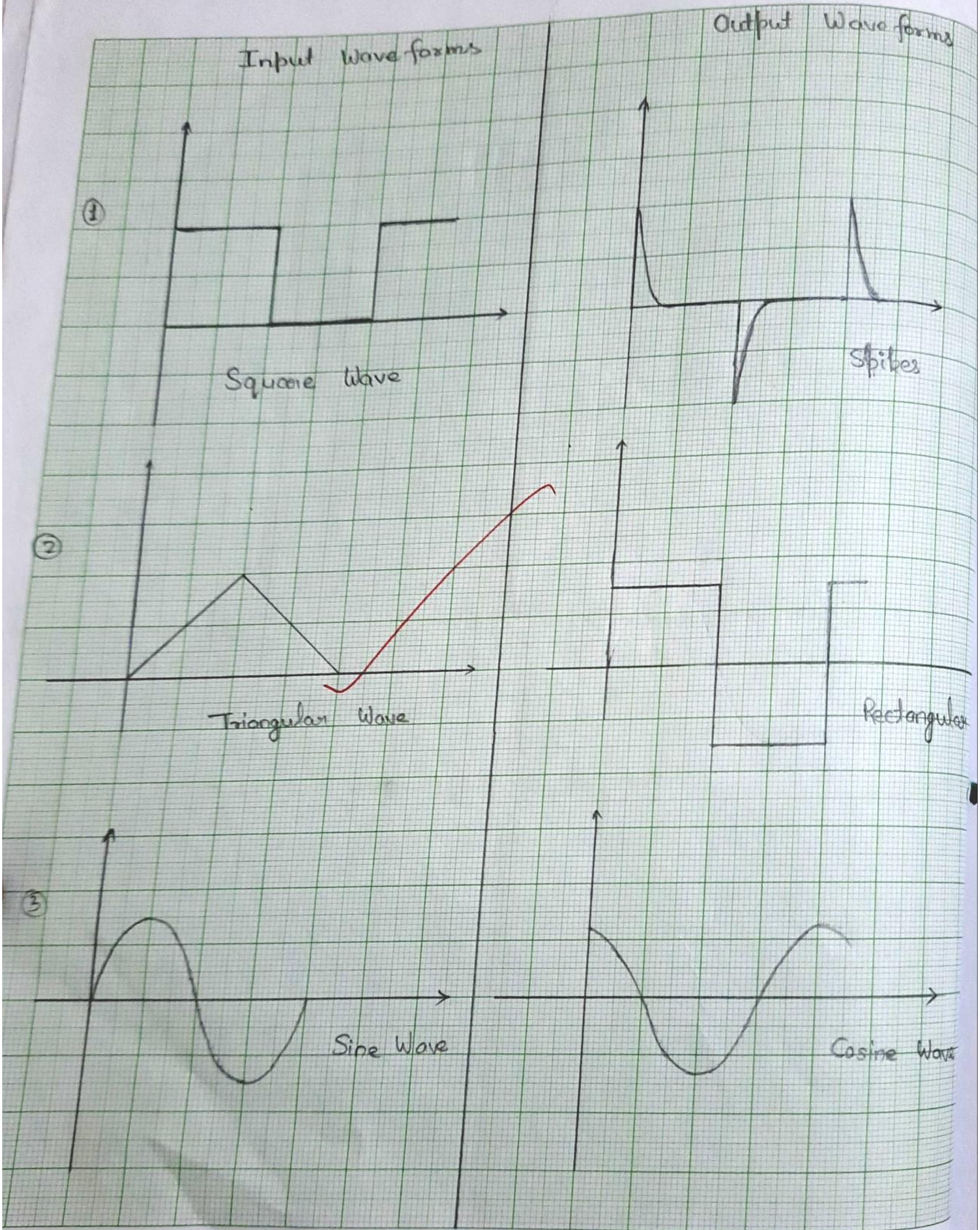
Theory :- The operation amplier circuit performs the mathematical operation of differentiation that it is produces a voltage output which is directly proportional to input voltages rate of change with respect to time. The faster or larger the change in input voltage signal, the greater input current, the greater will be the change in output voltage. ~~change~~ in respone becoming more of a 'spike' in shape.

The Input Voltages are -

1. Square Wave
2. Sine Wave

The corrosponding Output Voltages are -

1. Spikes
2. Cosine


Input Wave forms
Output Wave forms
1
Square Wave
Spikes
2
Triangular Wave
Rectangular
3
Sine Wave
Cosine Wave

Observations :-

- Frequency Variation :- On increasing the frequency of input waveforms, number of cycle in output waveform increases and there is no distortion in output waveforms.

- Amplitude Variation :- On increasing the amplitude of inputwave forms, polarity of the graph changes because the OP-Amp is in Inverting mode.

Result :- We have studied OP-Amp. as differentiator.

Precautions :-

1. All connections should be tight.
2. Check the connections before starting experiment.

Prince

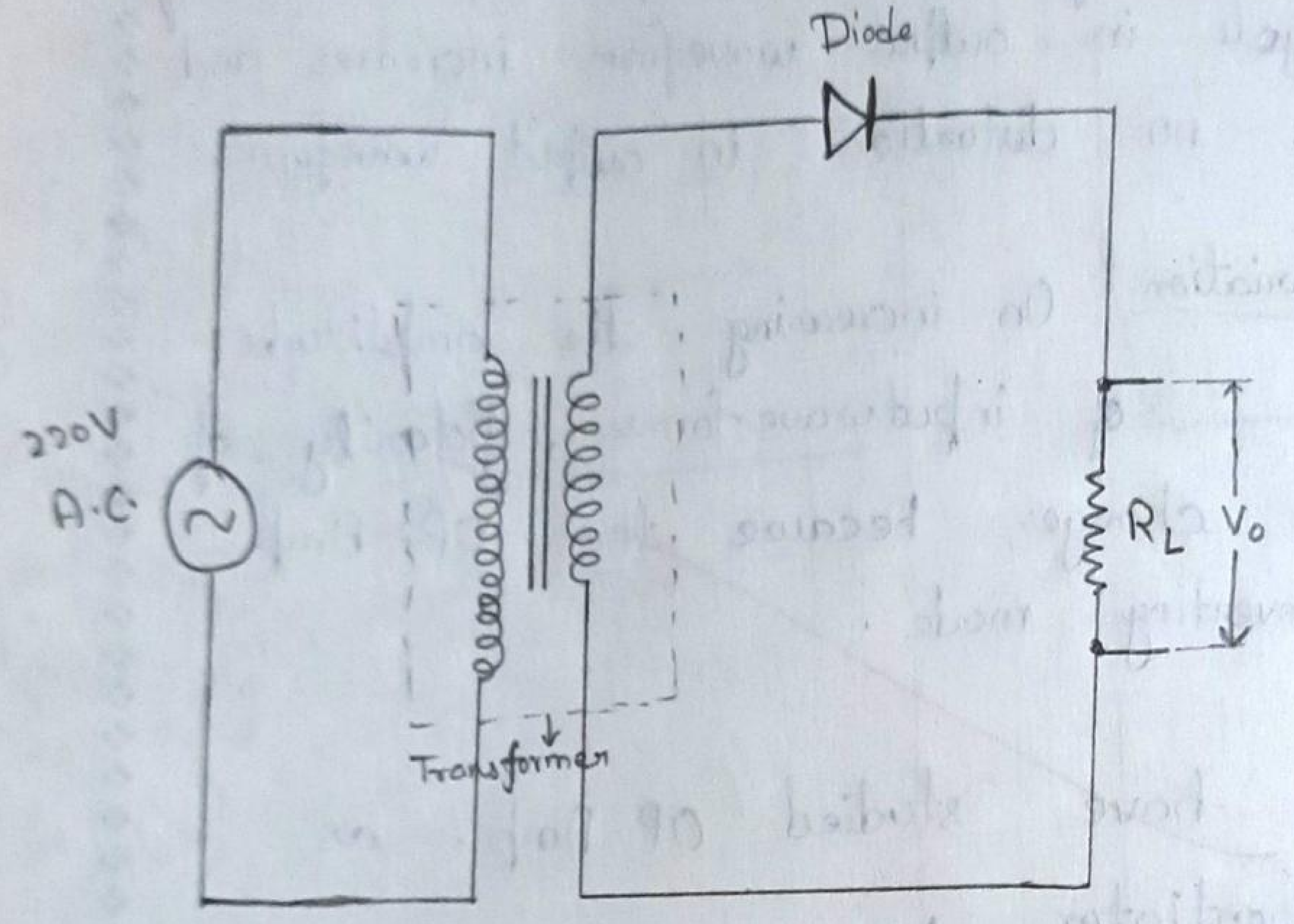


Fig :- Circuit Diagram of Half Wave Rectifier

Experiment no. - 08

Object :- Study of half wave rectifier, draw the input and output waveform and calculate the ripple factor.

Apparatus Used :- Cathode Ray Oscilloscope, half wave rectifier Transistor

Theory :- The half wave rectifier converts an AC voltage to DC voltage. The primary coil of the transformer is connected to AC supply. This ideas an AC voltage across the secondary coil.

- During (+)ve half cycle of input i.e. is forward biased and results current flows diode across the load resistance.

- During (-)ve half cycle ; diode is reverse biased and hence acts as open circuit. No current flows across ~~load~~ resistance.

Ripple factor :- It is defined as the ratio of RMS value of A.C. component to DC component in Output.

$$R.F. \quad R = \frac{V_{AC}}{V_{DC}} = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$I_m = \frac{V_m}{R_L} , \quad I_{DC} = \frac{I_m}{\pi}$$

$$I_{RMS} = \frac{I_m}{2}$$

TUTORIAL / PRACTICAL NO.

Where, I_m - Peak value of current

V_m - Peak value of voltage

R_L - Load Resistance

I_{dc} - DC current (Component of Output)

I_{rms} - Root Mean Square Current

Observation Table :-

S.No.	Voltage (in V)	Peak Current (in mA)	Resistance R_L (K-Ω)
1.	1	0.3	1
2.	1.5	0.8	1
3.	2	1.3	1

Calculation :-

(1) $I_m = 0.3\ mA$, $V_m = 1V$, $R_L = 1K\Omega \Rightarrow I_m = \frac{V_m}{R_L} = \underline{1\ mA}$

$I_{DC} = \frac{I_m}{\pi} = \frac{0.3\ mA}{3.14} = 0.0955414013 = 0.096$

$I_{rms} = \frac{I_m}{2} = \frac{0.3}{2.00} = 0.15$

$R.F. = \sqrt{\left(\frac{0.15}{0.096}\right)^2 - 1} = 1.2006$

$Error = \frac{1.21 - 1.2006}{1.21} \times 100 = 0.77\ \%$

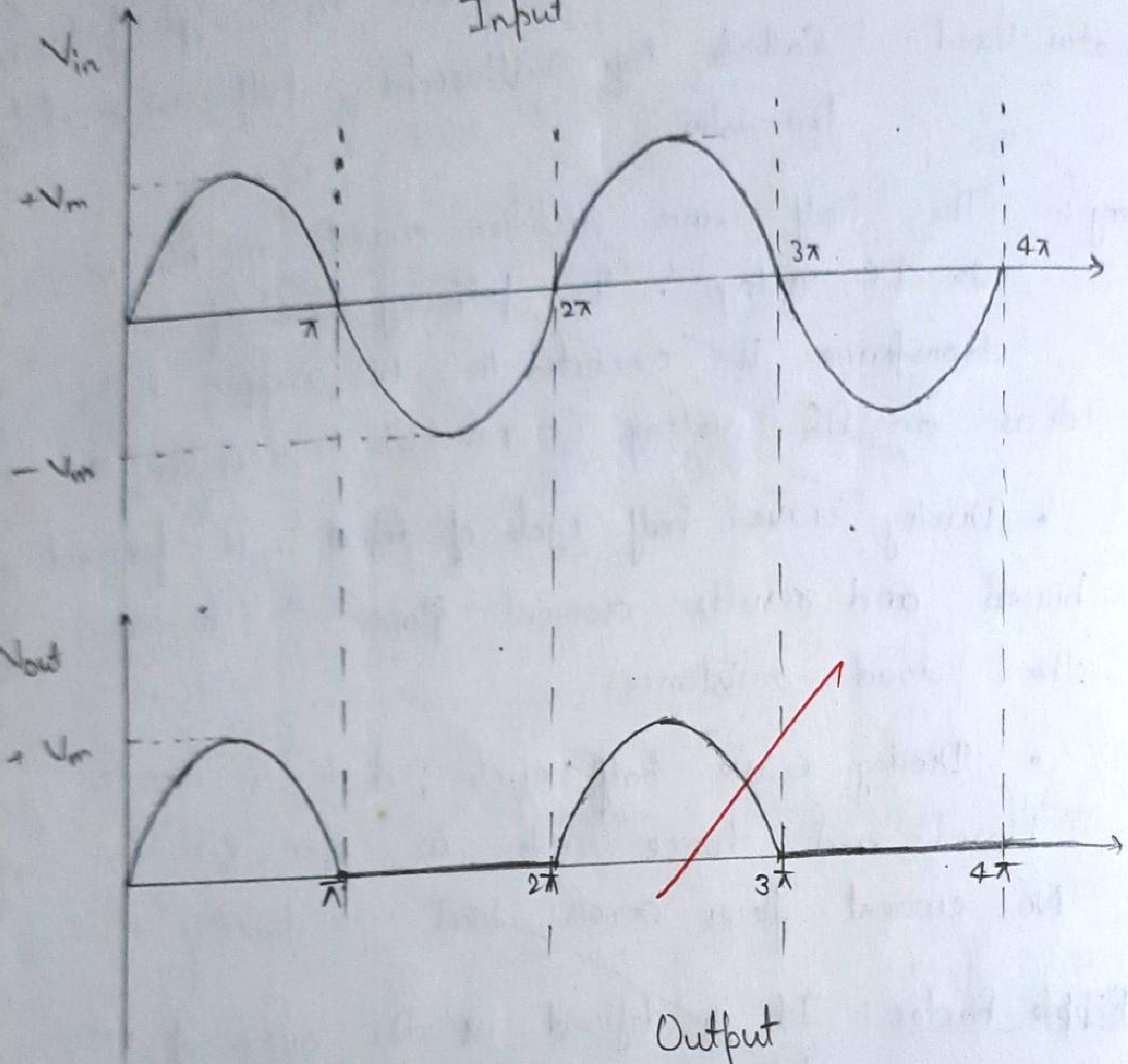
(2) $I_m = 0.8\ mA$, $V_m = 1.5V$, $R_L = 1K\Omega \Rightarrow I_m = \frac{V_m}{R_L} = 1.5\ mA$

$I_{DC} = \frac{I_m}{\pi} = \frac{0.8}{3.14} = 0.255$

$I_{rms} = \frac{I_m}{2} = \frac{0.8}{2} = 0.4$

$RF = \sqrt{\left(\frac{0.400}{0.255}\right)^2 - 1} = 1.209$

$Error = \frac{1.21 - 1.2009}{1.21} \times 100 = 0.1\ \%$


Input
V_{in}
$+V_m$
$-V_m$
π
2π
3π
4π
V_{out}
$+V_m$
π
2π
3π
4π
Output

③ $I_m = 1.3\,mA$, $V_m = 2V$, $R_L = 1K\Omega \Rightarrow I_m = \frac{V_m}{R_L} = 2\,mA$

$I_{dc} = \frac{I_m}{\pi} = \frac{1.3\,mA}{3.14} = 0.414$

$I_{rms} = \frac{I_m}{2} = \frac{1.3}{2} = 0.65$

$RF = \sqrt{\left(\frac{0.65}{0.414}\right)^2 - 1} = 1.2104$

$Error = \frac{1.21 - 1.21}{1.21} \times 100 = 0\,\%$

Result :- The ripple factor of half wave rectifier 1.21. with average error of 0.29 %.

Precautions :-

1. Ensure for continuous power supply.
2. All the connections should be tight.
3. Keep away from naked wire.
4. Avoid parallax.

prince

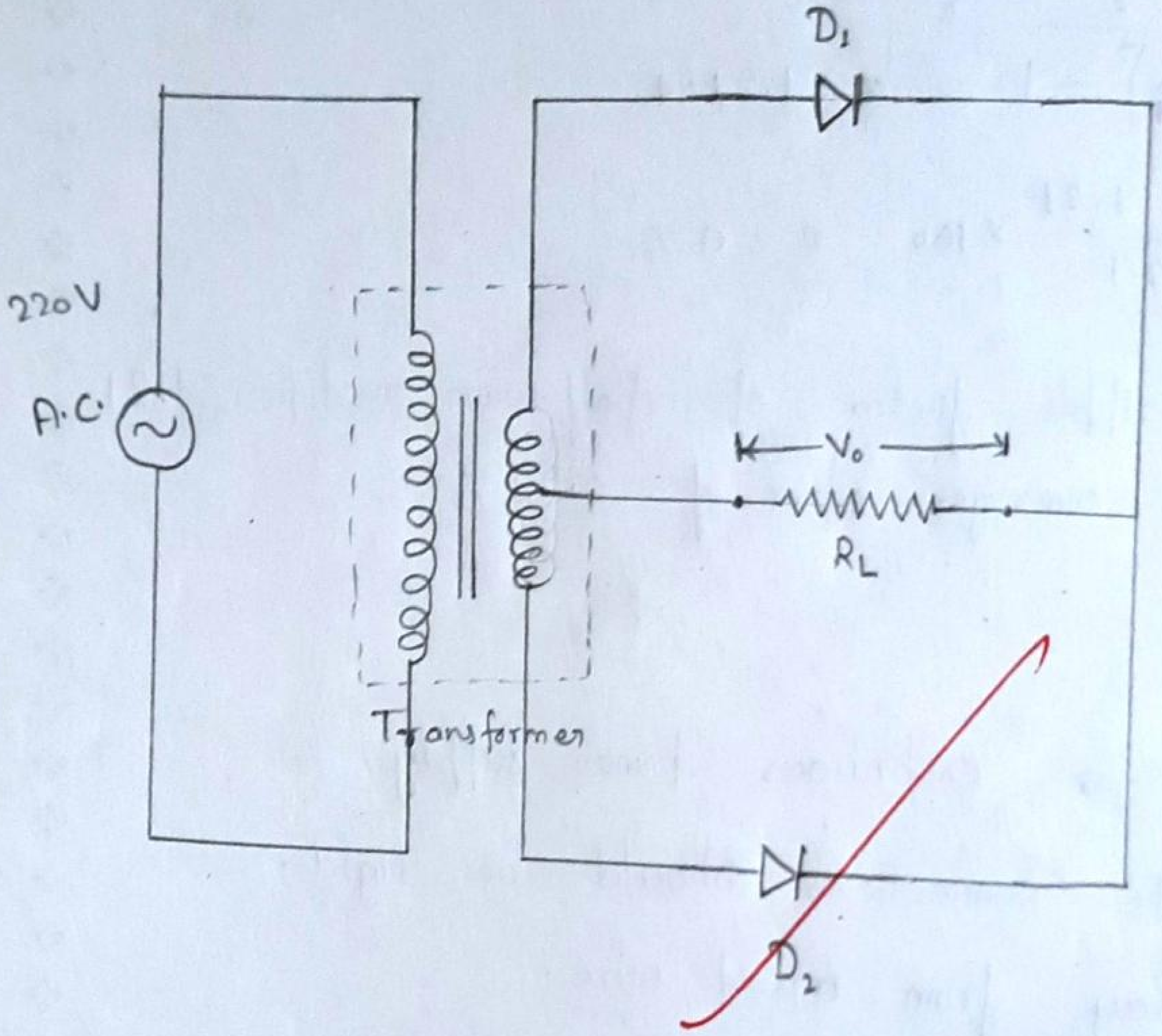


Fig :- Circuit Diagram of Central - Tapped Full Wave Rectifier

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Experiment no. 9

Object :- Study of full wave rectifier and draw the nature of input and output signal, calculate the value of I_{DC}, I_{rms} and Ripple factor.

Apparatus Used :- Cathode Ray Oscilloscope, Full wave rectifier, connecting wires.

Theory :- A full wave rectifier is used to convert an AC voltage with two diodes out of which one is conducting during (+)ve half cycle and other during second half cycle.

During (+)ve half cycle D_1 is forward biased while D_2 is reverse biased. Hence we get current across R_L due to D_1.

During (-)ve half cycle D_2 is forward biased and D_1 is reverse biased. Hence we get current across R_L due to diode D_2.

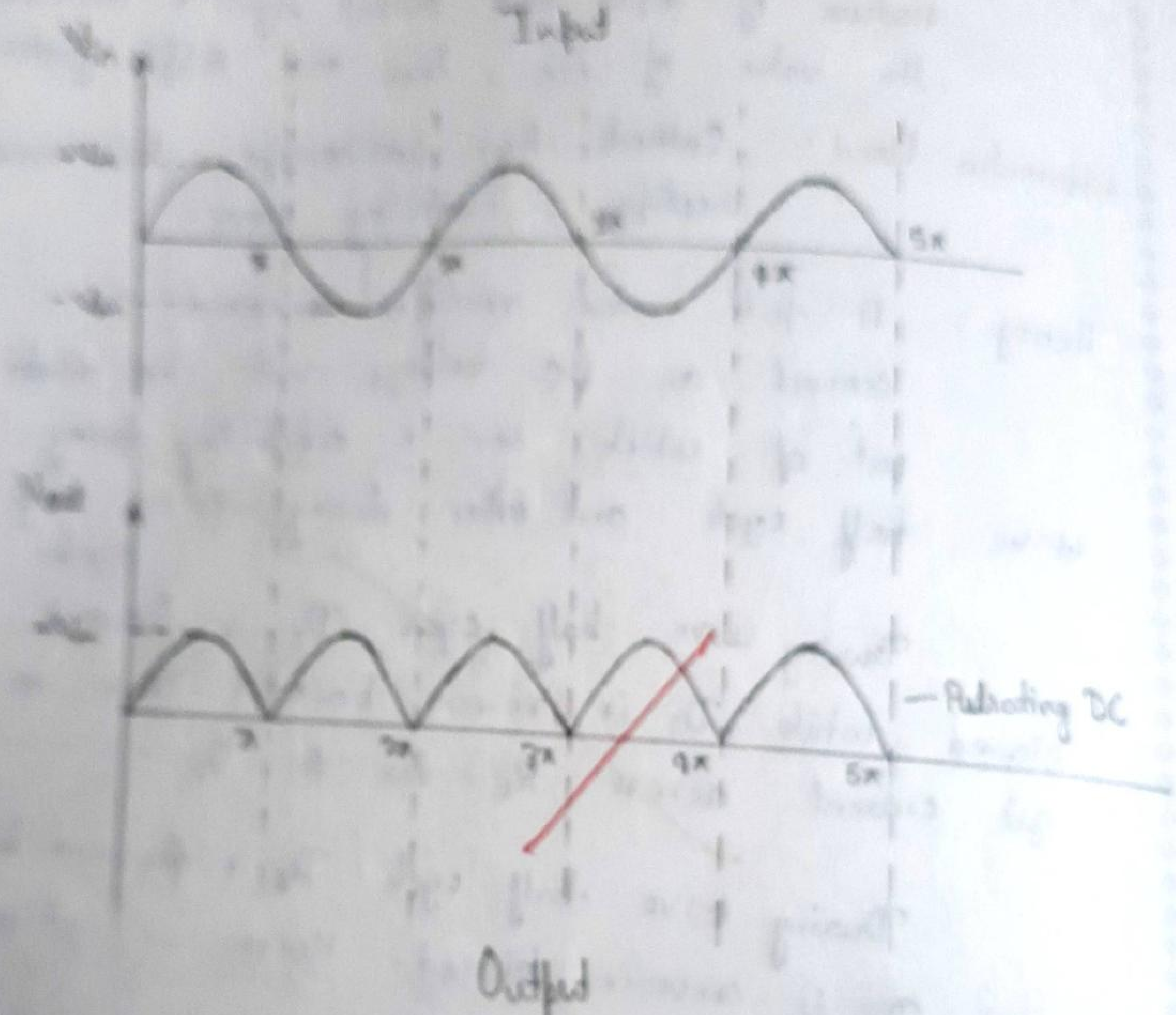
$$I_m = \frac{V_m}{R_L} \qquad , \qquad V_{DC} = \frac{2V_m}{\pi}$$

Ripple factor :-

$$R = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$I_{DC} = \frac{2I_m}{\pi}$$


Input
Pulsating DC
Output

Observation Table :-

S. No.	Voltage V_m (in V)	Peak Current I_m (in mA)	Resistance R_L (Ω)
1.	1	2	1000
2.	1.5	4	1000
3.	2	5.5	1000

Calculation :- $V_m = 12.5\,V$, $R_L = 1\,K\Omega = 10^3\,\Omega$

$$I_m = \frac{V_m}{R_L} = \frac{12.5}{10^3} = 12.5 \times 10^{-3}\ A$$

$$I_{DC} = \frac{2I_m}{\pi} = \frac{2 \times 12.5 \times 10^{-3}}{3.14} = 7.98 \times 10^{-3}\ A$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{12.5 \times 10^{-3}}{\sqrt{2}} = 8.84 \times 10^{-3}\ A$$

$$RF = \sqrt{\left(\frac{8.84 \times 10^{-3}}{7.98 \times 10^{-3}}\right)^2 - 1} = 0.48$$

Result :- The ripple factor of the full wave rectifier is 0.48

Precautions :-

1. Power supply should be continuous.
2. All connections should be tight.

Pankaj