V-I CHARACTERISTICS OF A PN JUNCTION DIODE

29/1/24

1. Aim:-

1. To plot the V-I characteristics of given p-n junction diode (IN4007).
2. To calculate the forward static Resistance and Dynamic Resistance.

2. Materials Used:-

2.1 Equipment Required:-

S-No	Description of Item	Range	Quantity
1.	DC Regulated power supply	0-30V/1A	1
2.	DC voltmeter	0-2V	1
3.	DC Milliammeter	0-100mA	1
4.	Breadboard	—	1

2.2 Components Required:-

S-No	Description of Item	Range	Quantity
1.	P-N Junction Diode	IN4007	1
2.	Resistors	330Ω	1

3. Theory:-

4. Circuit Diagram:-

Forward Bias:-

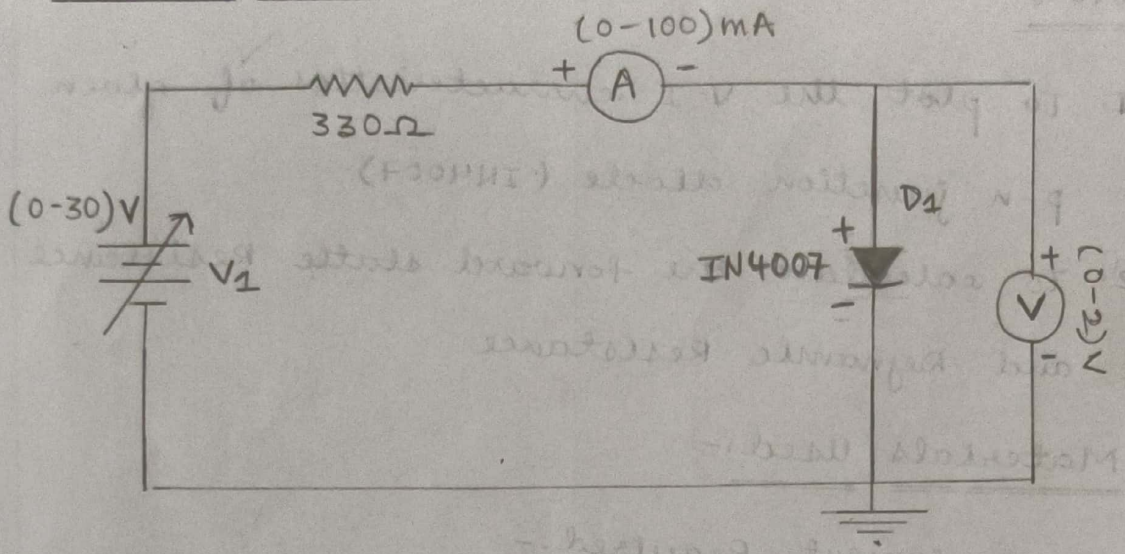


fig. PN Junction diode under forward bias

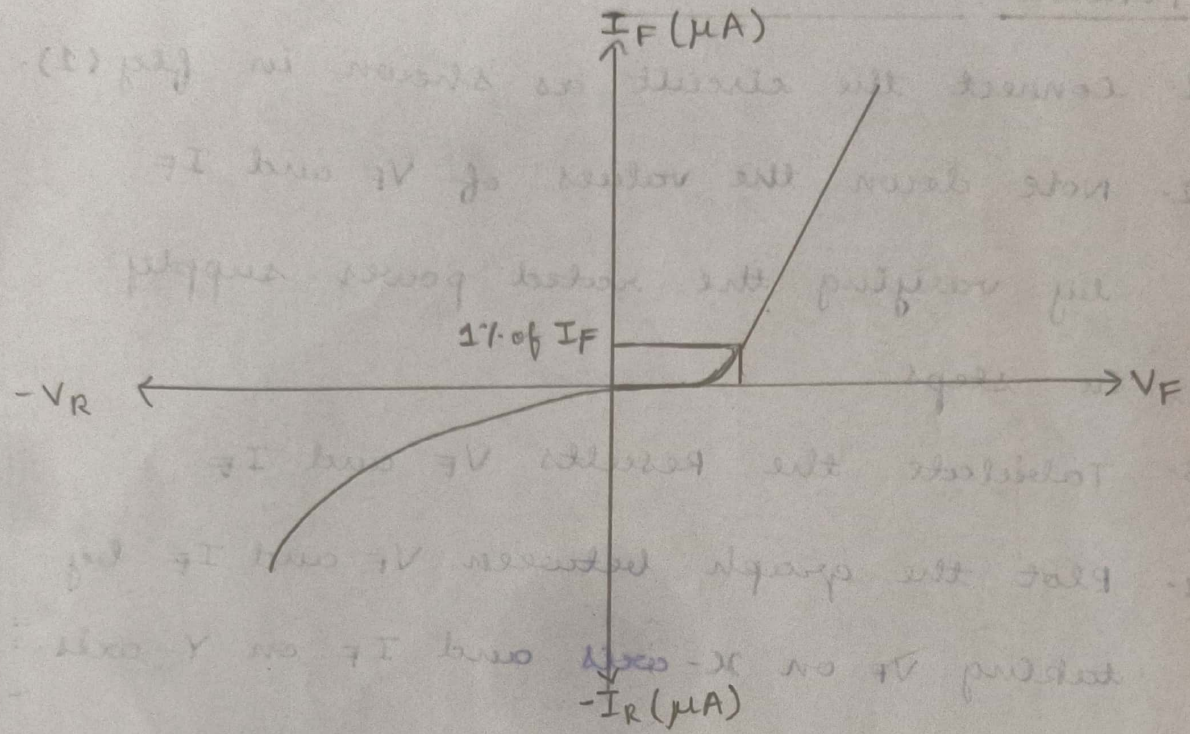
6. Observations:-

Forward Bias characteristics:-

6.1 Tabular Data:-

V_F (Volts)	I_F (mA)	V_R (V)	I_R (mA)
0.0	0.0	0.693	13
0.427	0.3	0.696	14
0.555	1	0.700	15
0.585	2	0.702	16
0.618	3	0.706	17
0.630	4	0.709	18
0.646	5	0.711	19
0.652	6	0.714	20
0.662	7	0.735	30
0.668	8	0.749	40
0.674	9		
0.678	10		
0.685	11		
0.690	12		

6-2 Expected Graph :-



6-3 Calculations :-

Static Resistance = $\frac{V}{I} = \frac{0.678}{10 \times 10^{-3}} = \underline{67.8\ \Omega}$

Dynamic Resistance = $\frac{\Delta V}{\Delta I} = \underline{3.6\ \Omega}$

$I_1 = 10$, $I_2 = 20$

$V_1 = 0.678$, $V_2 = 0.714$

$\therefore \frac{|\Delta V|}{\Delta I} = \frac{0.714 - 0.678}{(20-10)10^{-3}} = \frac{0.036}{10 \times 10^{-3}} = 3.6\ \Omega$

9. Result:-

Static Resistance = 67.8 Ω

Dynamic Resistance = 3.6 Ω

Specifications:- for silicon diode IN4007:-

Max. Forward current = 1A

Max. Reverse current = 30μA

Max. Forward Voltage = 0.8V

Max. Reverse voltage = 1000V

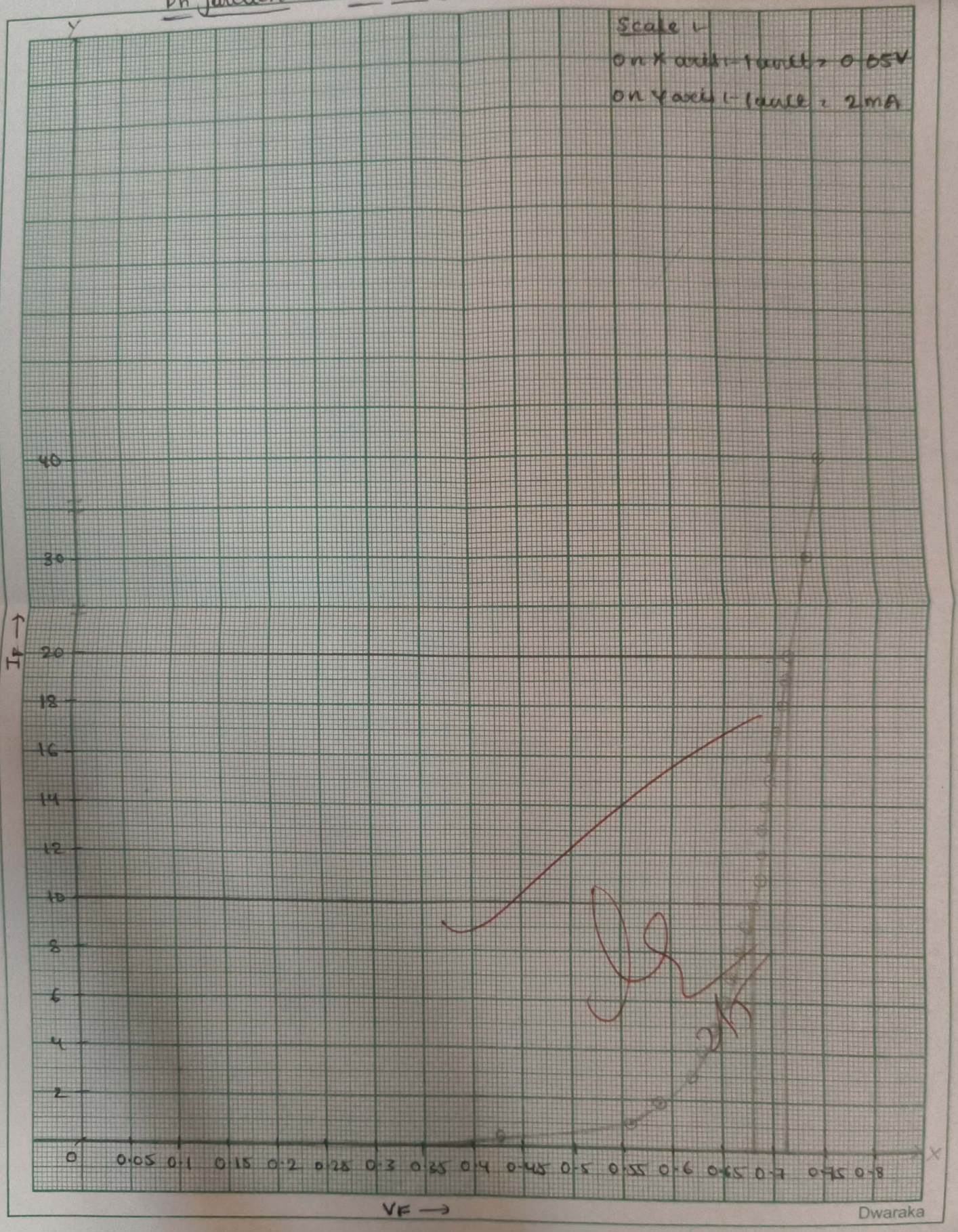
Max. power dissipation = 30 mW

Temperature = -65 to 200°C

10. Applications of Diode:-

1. Rectifiers in DC power supplies.
2. As a switch.
3. In clamping, clipping circuits.
4. Modulators, demodulators.
5. Used in bias stabilization circuits.
6. As a variable capacitance.
7. In voltage tuning of LC resonant circuit.
8. Switch in digital logic circuits

Pn junction I- VF vs IF



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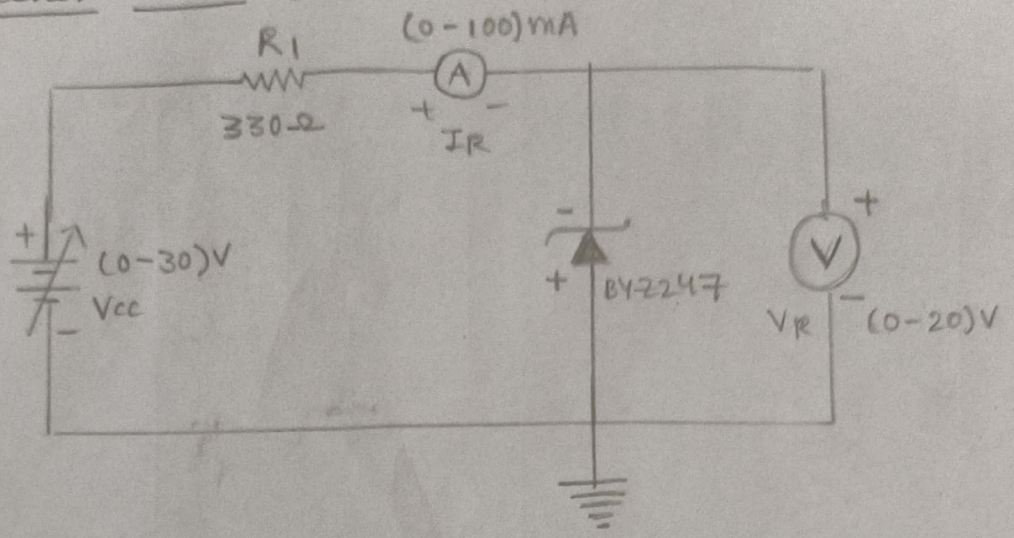
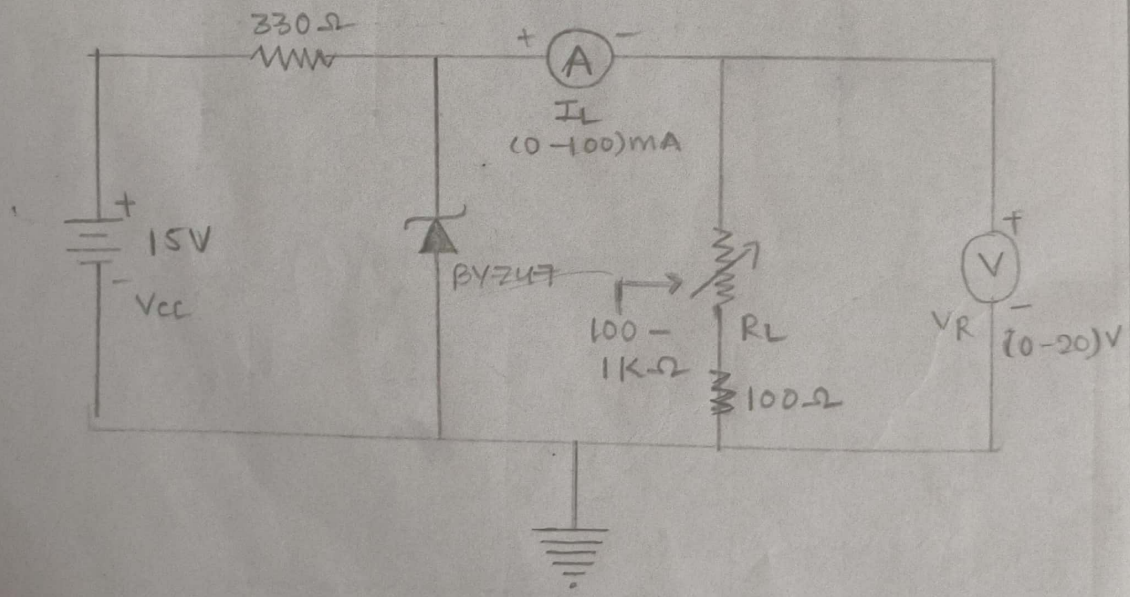
4) CIRCUIT DIAGRAM :-

Zener diode characteristics :-



Zener Regulator characteristics :-



ZENER AS A VOLTAGE REGULATOR

Aim :-

- To plot the reverse characteristics of zener diode.
- To determine the reverse breakdown voltage and reverse resistance of zener diode.
- To determine the voltage Regulation.

Materials Required :-

Equipment required :-

SNo	Description of Item	Range	Quantity
1.	DC Regulated power supply	(0-30)V	1
2.	DC Voltmeter	(0-20)V	1
3.	DC Milliammeter	(0-100)mA	1
4.	Bread board	—	1

Components Required :-

S-No.	Description of Item	Range	Quantity
1.	Zener diode	BYZ47	1
2.	Resistor	330Ω 100Ω	1 1
3.	Variable Resistor	1KΩ pot	1

Theory :-

6) OBSERVATION:-

Reverse characteristics of zener:-

V_R (Volts)	I_R (mA)
0	0
1	0
2	0
3	0
3.91	0.5
4.75	2
4.83	4
4.87	6
4.89	8
4.89	10
4.90	12
4.91	14
4.92	16
4.92	18
4.93	20
4.95	30
4.98	40

Load Regulation characteristics:-

R_L (Ω)	I_L (mA)	V_Z (V)	Percentage Regulation.
100	36	3.71	33.6 %
200	21	4.89	1.43 %
300	14	4.91	1.01 %
400	10	4.93	0.60 %
500	8	4.92	0.81 %
600	6	4.93	0.60 %
700	5	4.93	0.60 %
800	4	4.94	0.40 %
900			
1000			

V_{DC} (NL) = 4.96

Zener breakdown voltage, V_Z (at I_{ZT}) = 4.93

Procedure :-

Reverse - Bias :-

- connect the circuit as per the circuit diagram.
- By varying the (Regulated power supply) RPS in steps Note down the ammeter and voltmeter readings (V_R and I_R).
- Plot the graph between V_R and I_R. Then Indicate the Knee voltage (V_{th}) and static and dynamic resistance.

Static Resistance (DC Resistance), $R = V_R / I_R$

Dynamic Resistance (AC Resistance), $r = V_r / I_r$

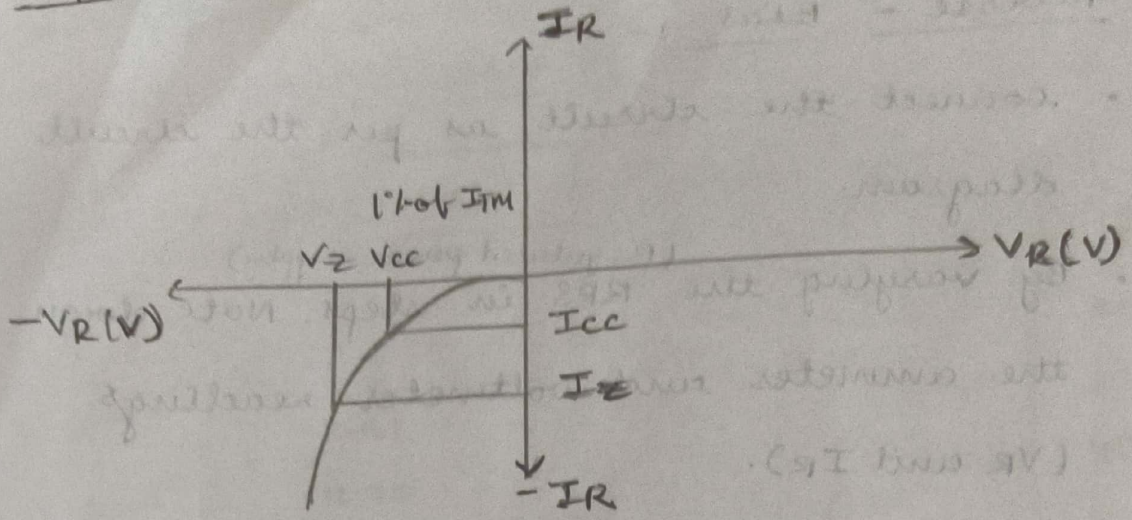
Regulator Characteristics :-

- connect the circuit as per circuit diagram.
- Set $V_{cc} = 15V$ in the RPS.
- By varying load Resistance, note down the voltmeter (V_L) and Ammeter (I_L) readings.
- Plot the graph between R_L and the % regulation.

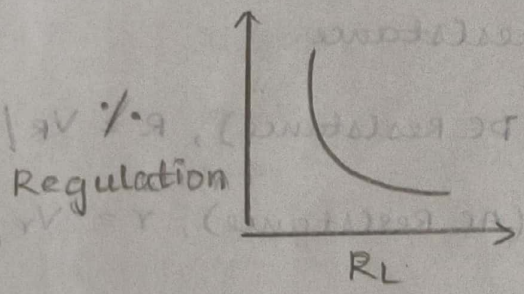
Precautions :-

- Do not short circuit the load terminals. Always start with some minimum load resistance.

Expected Graph:-



Reverse characteristics of zener load Regulation:-



Calculations:- Reverse characteristics:-

Static Resistance = $\frac{V}{I} = \frac{4.89}{10 \times 10^{-3}} = 489\ \Omega$

Dynamic Resistance = $\frac{\Delta V}{\Delta I} = \frac{4.93 - 4.89}{(20-10)10^{-3}} = 4\ \Omega$

% regulation = $((V_{NL} - V_{FL})/(V_{FL})) \times 100$

$$= \frac{33.67 + 1.43 + 1.01 + 0.60 + 0.81 + 0.60 + 0.60 + 0.40}{8}$$

$$= 4.88\%$$

NOTE:- find resistances in linear portion of the characteristics.

- Readings should be taken without parallax error.

8. Analysis :-

1. In Reverse bias, initially the current is negligable as diode is not in conducting state.
2. As load resistance (RL) increases, the regulation decreases.
3. Static resistance is greater than dynamic resistance.

9. Results :-

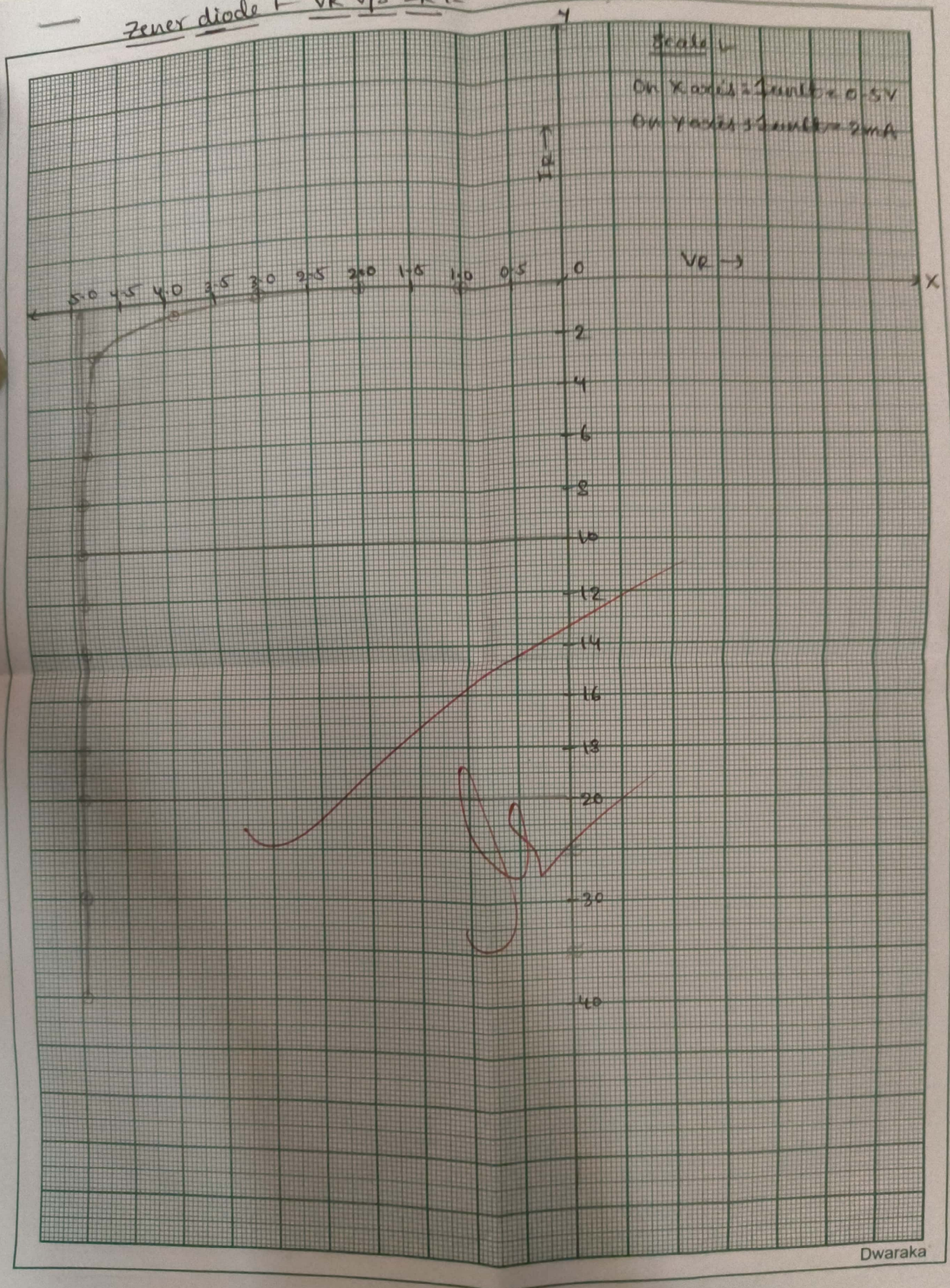
Zener breakdown voltage = 4.93 V

% Voltage Regulation = 4.88 %.

Applications of Zener diode :-

- To regulate the voltage against the variation in supply voltage or load current.
- In linear wave shaping circuits.
- In non-linear wave shaping circuits like clipping and clamping circuits.

Zener diode :- V_R v/s I_R :-



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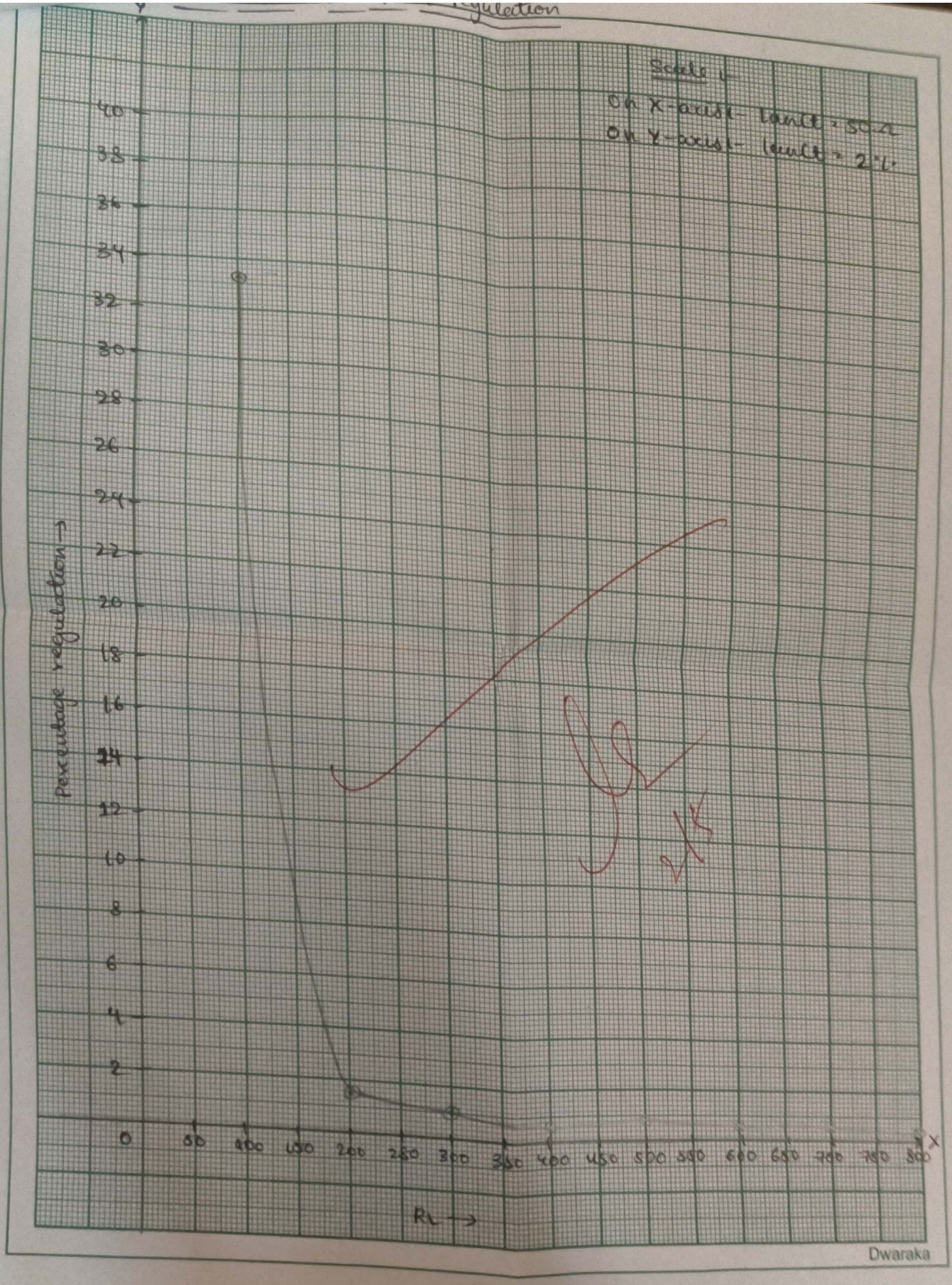
Regulation
Scale :-
On X-axis :- 1 unit = 50 Ω
On Y-axis :- 1 unit = 2 %
Percentage regulation →
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
X
RL →
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4) CIRCUIT DIAGRAM :-

Half wave Rectifier :-

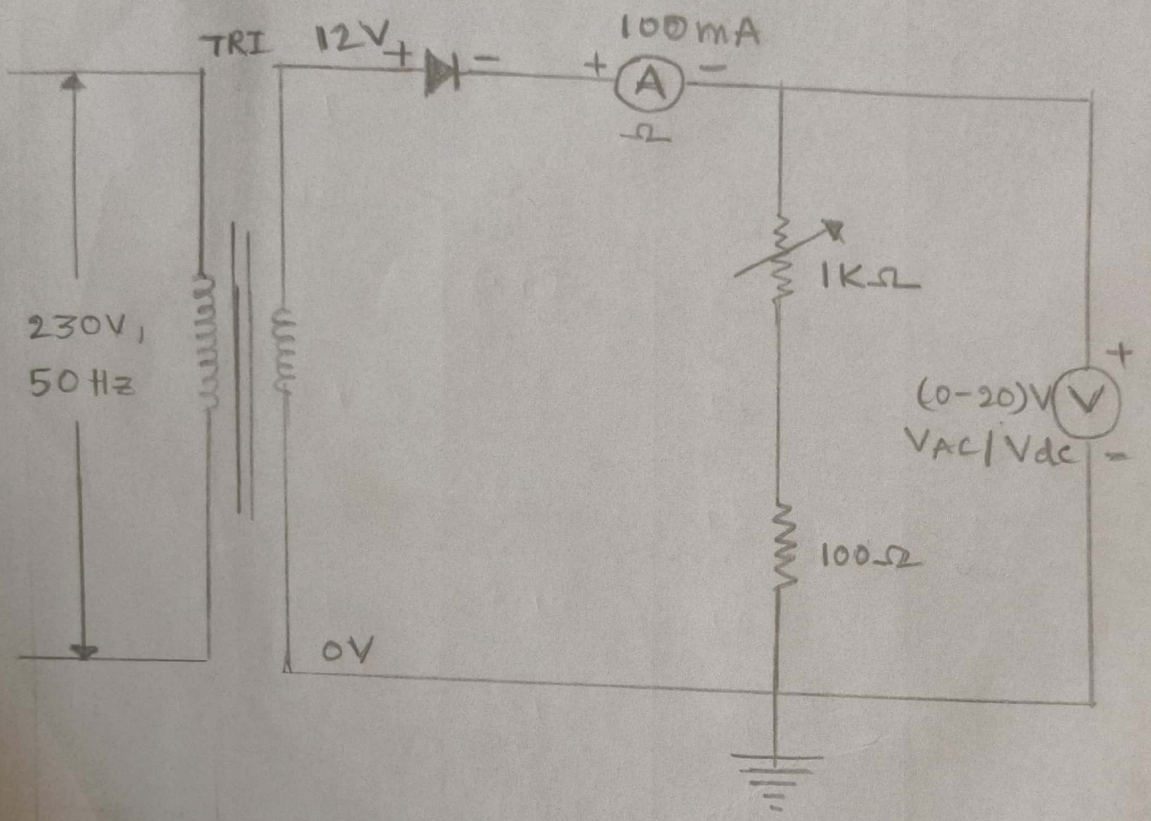

Fig 4-1 :- Half wave Rectifier

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HALF WAVE RECTIFIER

1. Aim:-

1. To find the average ripple factor, average percentage regulation and average Vdc for the half wave rectifier.
2. To plot the response of the ripple factor and Vdc for various values of Idc.

2. Materials Required:-

Equipment required:-

S.No	Description of Item	Range	Quantity
1.	Step down transformer	230V/12V, 50Hz	1
2.	DC Voltmeter	(0-20)V	1
3.	DC milliammeter	(0-100) mA	1
4.	Bread board	—	1

Components required:-

S.No	Description of Item	Range	Quantity
1.	Diode	1N4007	1
2.	potentiometer	1KΩ	1
3.	Capacitor	220μf	1
4.	Resistor	100Ω	1

3. Theory:-

6) OBSERVATION :-

6-1) Tabular data :-

Half wave rectifier without filter :-

$R_L(\Omega)$	$\bar{V}$ (DC) $V_{DC}(V)$	V_{rms} (AC) $V_{AC}(V)$	$I_{DC}(mA)$	Ripple factor
100	4.61	5.84	50	1.267
200	5.12	6.55	26	1.279
300	5.33	6.82	18	1.279
400	5.41	6.96	14	1.286
500	5.45	7.05	12	1.293
600	5.49	7.10	10	1.293
700	5.55	7.15	9	1.288
800	5.60	7.20	8	1.285
900	5.65	7.23	7	1.279
1000	5.67	7.25	6	1.278
1100	5.68	7.27	6	1.279

$\therefore V_{DC}(NL) =$ 8.35 V

$\therefore V_{DC}(FL) =$ 5.68 V

5. Procedure :-

1. Connect the circuit as shown above.
2. AC voltage across the secondary windings or terminals of the transformer should be verified.
3. The potentiometer was varied such that the load current is varied from min to max value in steps.
4. Readings of Vac, Vdc, Idc and R_L are to be noted.
5. Calculate ripple factor and regulation.

7. Analysis :-

→ In the graph plotted b/w R_L and ripple factor, we can notice that the values of the ripple factor remains almost constant with varying load resistances.

→ In the graph plotted b/w Idc & Vdc, with increase in Idc values, Vdc values decreases linearly. Hence the slope of the graph is negative.

→ In every reading, the value of Vdc is less than the value of Vac, for every change

6-2) Calculations :-

Ripple factor = $V_{ac}/V_{dc} = \frac{7.27}{5.68} = 1.279$

percentage regulation = $\frac{(V_{dc(NL)} - V_{dc(FL)})}{V_{dc(FL)}} \times 100$

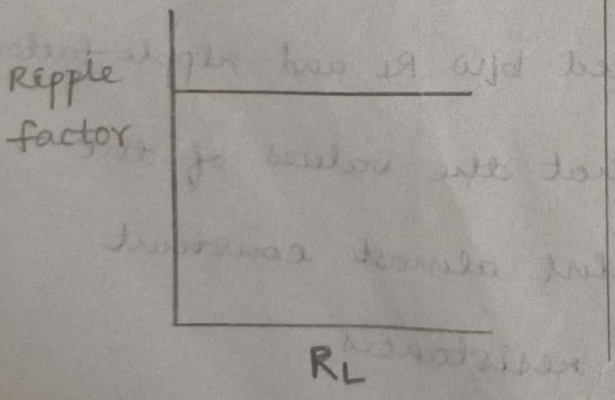
$= \frac{8.35 - 5.68}{5.68} \times 100$

$= 47\%$

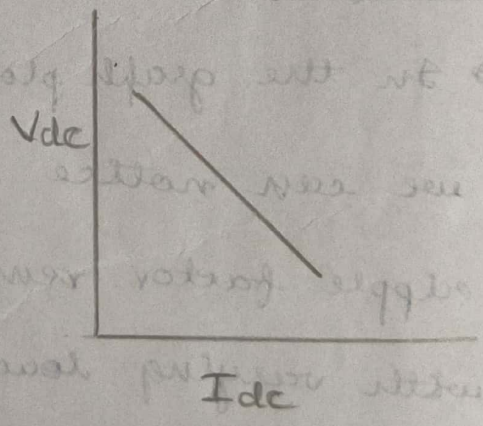
6-3) Expected graphs :-

Half wave Rectifier :-

(a) Load resistance (R_L) Vs Ripple factor



(b) I_{dc} V/s V_{dc}



in the Resistance.

8. **Precautions:-**

1) While doing the experiment, do not exceed the ratings of diode. This may lead to the damage of diode.

2) Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.

3) Do not switch on power supply unless you have checked the circuit connections as per the circuit diagram.

4) Before giving power supply to the circuit, make sure that the transformer terminals are properly connected.

9. **Results:-**

The response of the load voltage, ripple factor of half wave rectifier were noted down. the average ripple factor was found.

∴ Average V_{dc} = 5.414V

∴ Average ripple factor = 1.282

10. **Applications:-**

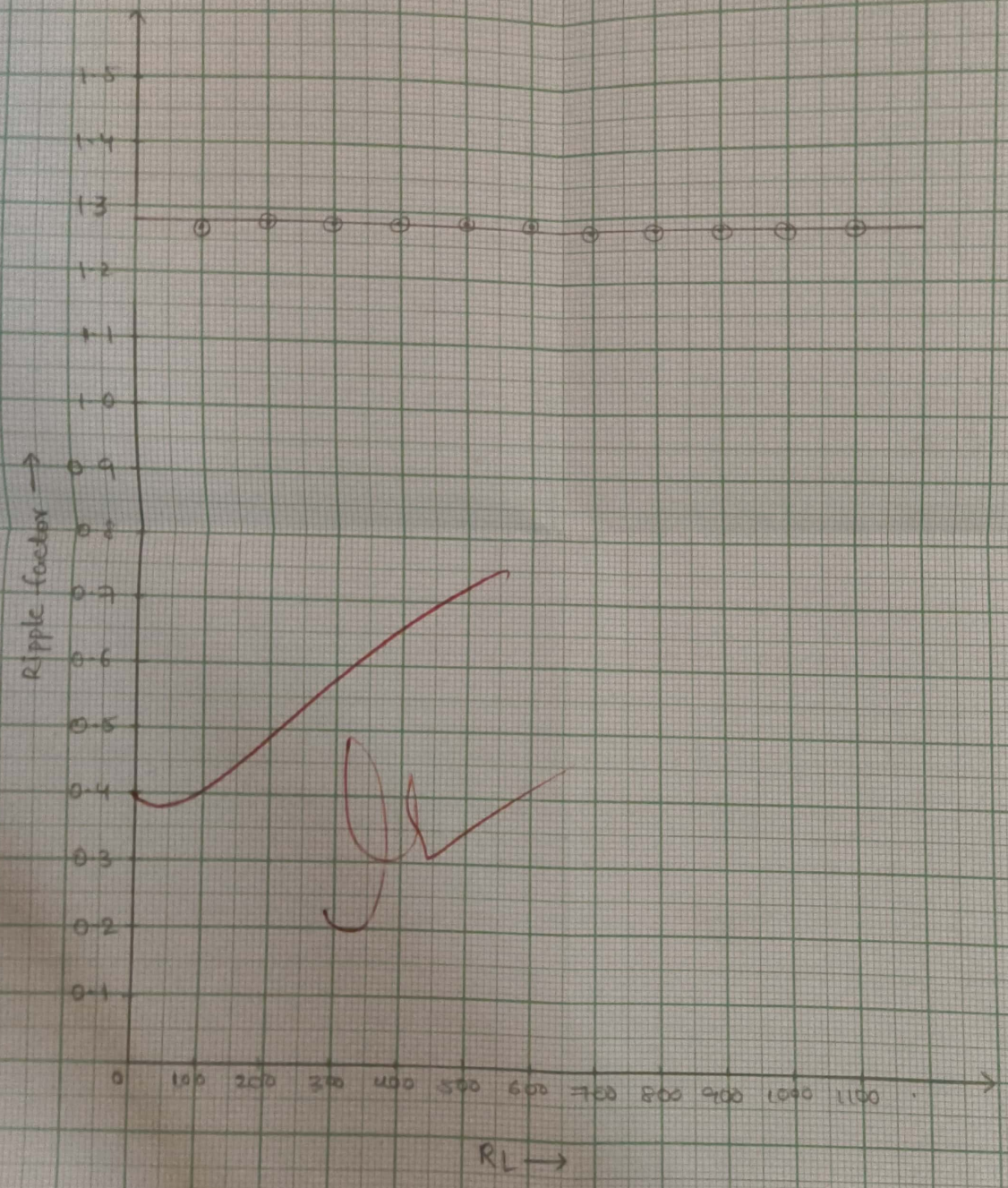
1. Regulated power supplies
2. Power circuits.

HWR :- R_L v/s Ripple factor :-

Scale :-

on x axis :- 1 unit = 100 Ω

on Y axis :- 1 unit = 0.1

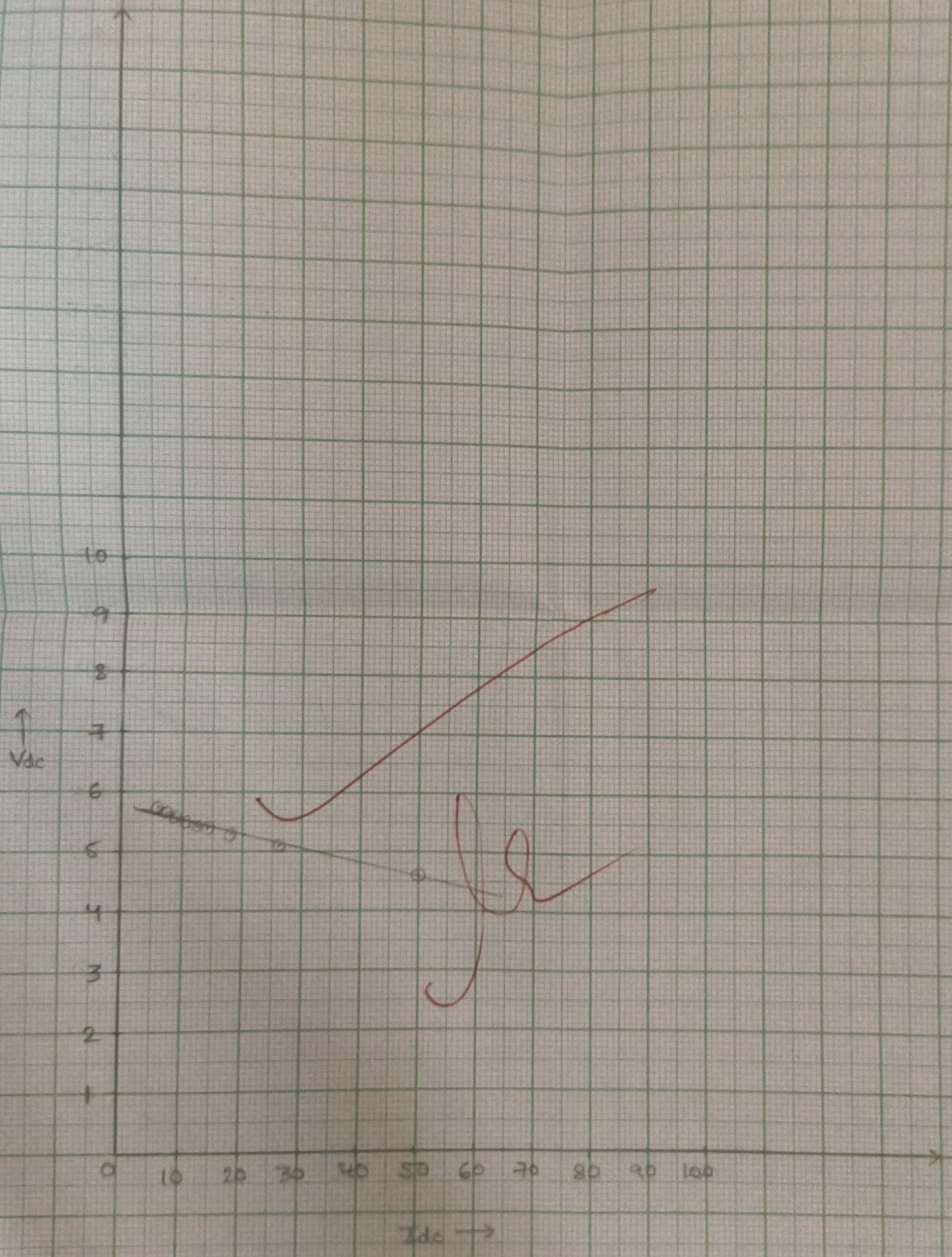


HWOR : Idc v/s Vdc

Scale :-

On x axis : 1 unit = 10 mA

On y axis : 1 unit = 1V



4) CIRCUIT DIAGRAM:-

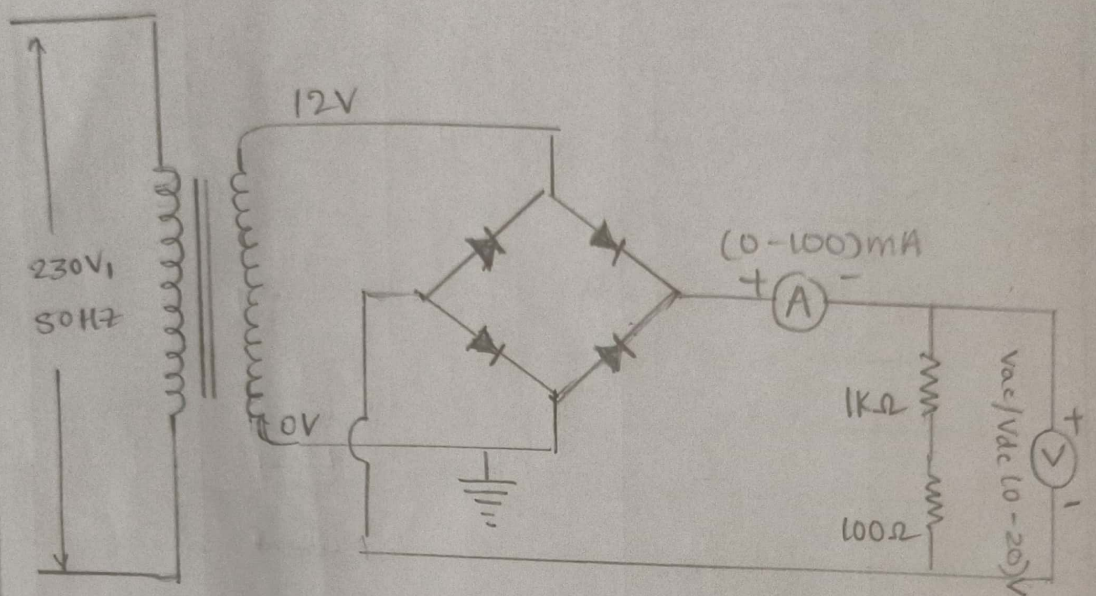


fig- full wave rectifier

2/10/25

FULL WAVE BRIDGE RECTIFIER

1. Aim :-

1) To find the average ripple factor, average percentage regulation and average Vdc for the full wave bridge rectifier.

2) To plot the response of the ripple factor and Vdc for various values of Idc.

2. Materials used :-

Equipment Required :-

S.No	Description of Item	Range	Quantity
1.	Step down transformer	230V/12V, 50Hz	1
2.	DC Voltmeter	0-20V	1
3.	DC Milli ammeter	0-100mA	1

Components Required :-

S.No	Description of Item	Range	Quantity
1.	Diode	1N4007	4
2.	Potentiometer	1KΩ	1
3.	Resistors	100Ω	1

3. Theory :-

5. Procedure :-

1) Connect the circuit as shown above.

2) AC voltage across the secondary windings or terminals of the transformer should be verified.

6) OBSERVATIONS

6.1) Tabular data :- full wave bridge rectifier :-

R_L (Ω)	Vdc (V)	Vac (V)	Idc (mA)	Ripple factor
100	8.16	4.41	86	0.540
200	9.42	4.98	48	0.528
300	9.84	5.22	34	0.530
400	10.05	5.34	26	0.531
500	10.18	5.41	21	0.531
600	10.21	5.44	18	0.532
700	10.30	5.45	16	0.530
800	10.37	5.47	14	0.527
900	10.39	5.47	12	0.526
1000	10.42	5.49	12	0.526
1100	10.44	5.51	10	0.527

6.2) Calculations :-

$V_{dc(NL)} = 13.96\,V$

$$\text{Ripple factor} = \frac{V_{ac}}{V_{dc}} = \frac{5.51}{10.44} = 0.527$$

$$\% \text{ regulation} = \frac{(V_{dc(NL)} - V_{dc(FL)})}{V_{dc(FL)}} \times 100$$

$$= \frac{13.96 - 10.44}{10.44} \times 100$$

$$= 33.7\,\%$$

3) The potentiometer was varied such that the load current is varied from minimum to maximum value in steps.

4) Readings of Vac, Vdc, Idc and RL to be noted.

5) Calculate ripple factor, regulation.

6) Plot the output waveform.

7. Analysis:-

→ In the graph plotted between RL and ripple factor, we can notice that the values of ripple factors almost remain constant with varying load resistances.

→ In the graph plotted between Idc & Vdc with increase in Idc values, Vdc values decreases linearly, Hence the slope of graph is negative.

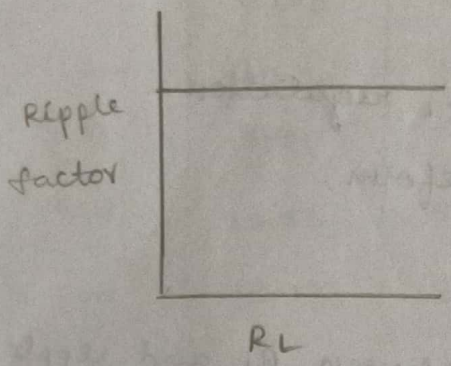
→ In every reading, the value of Vdc is greater than value of Vac for every change in the resistance and ripple factor is less than 1.

8. Precautions:-

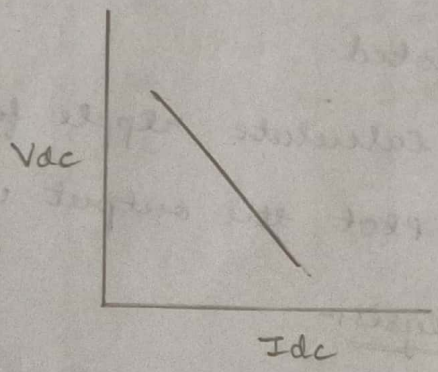
1) Connect Voltmeter and Ammeter in correct polarities as shown in circuit diagram.

6.3) Expected graphs

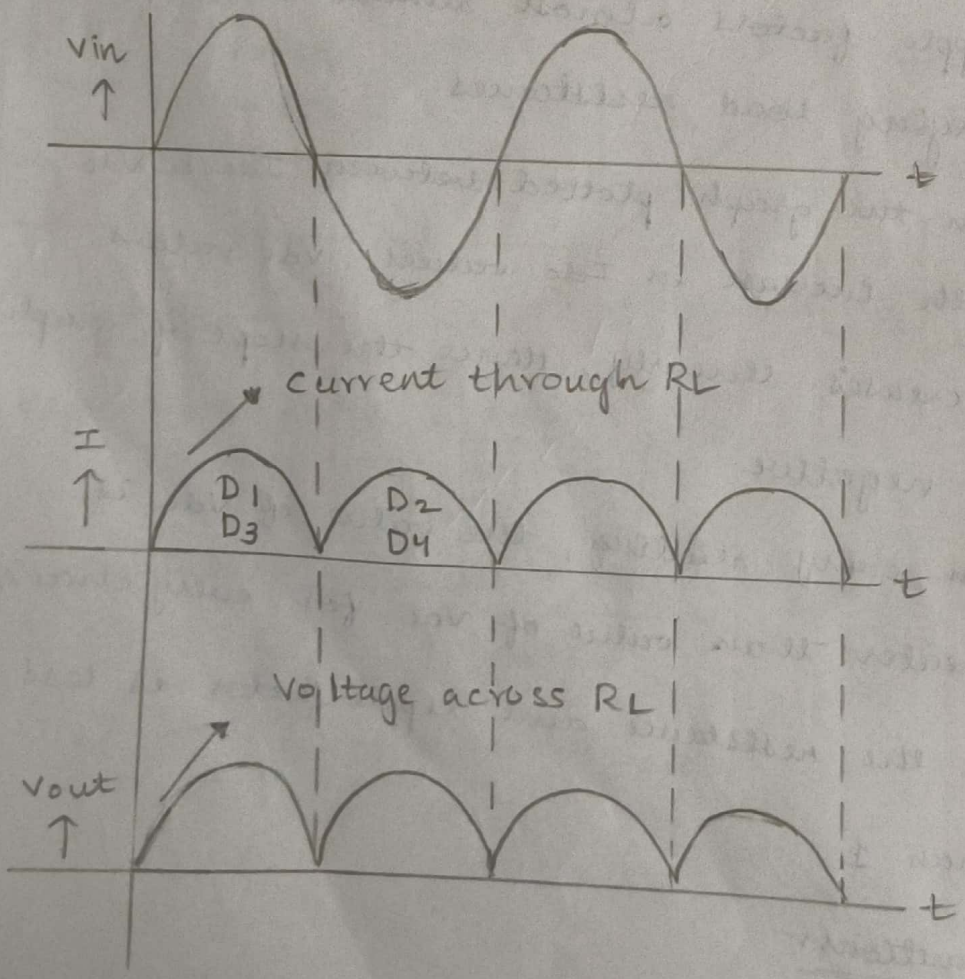
(a) Load Resistance R_L vs Ripple factor



(b) I_{dc} vs V_{dc}



Waveforms observed in CRO:-



2) Do not switch ON power supply unless you have checked the circuit connections as per the circuit diagram.

3) Before giving power supply to the circuit, make sure that the transformer terminals are properly connected.

9. **Results:-**

The response of load voltage, ripple factor of bridge rectifier were noted down. The average ripple factor was found.

∴ Average V_{DC} = 9.98 V

∴ Avg. Ripple factor = 0.529

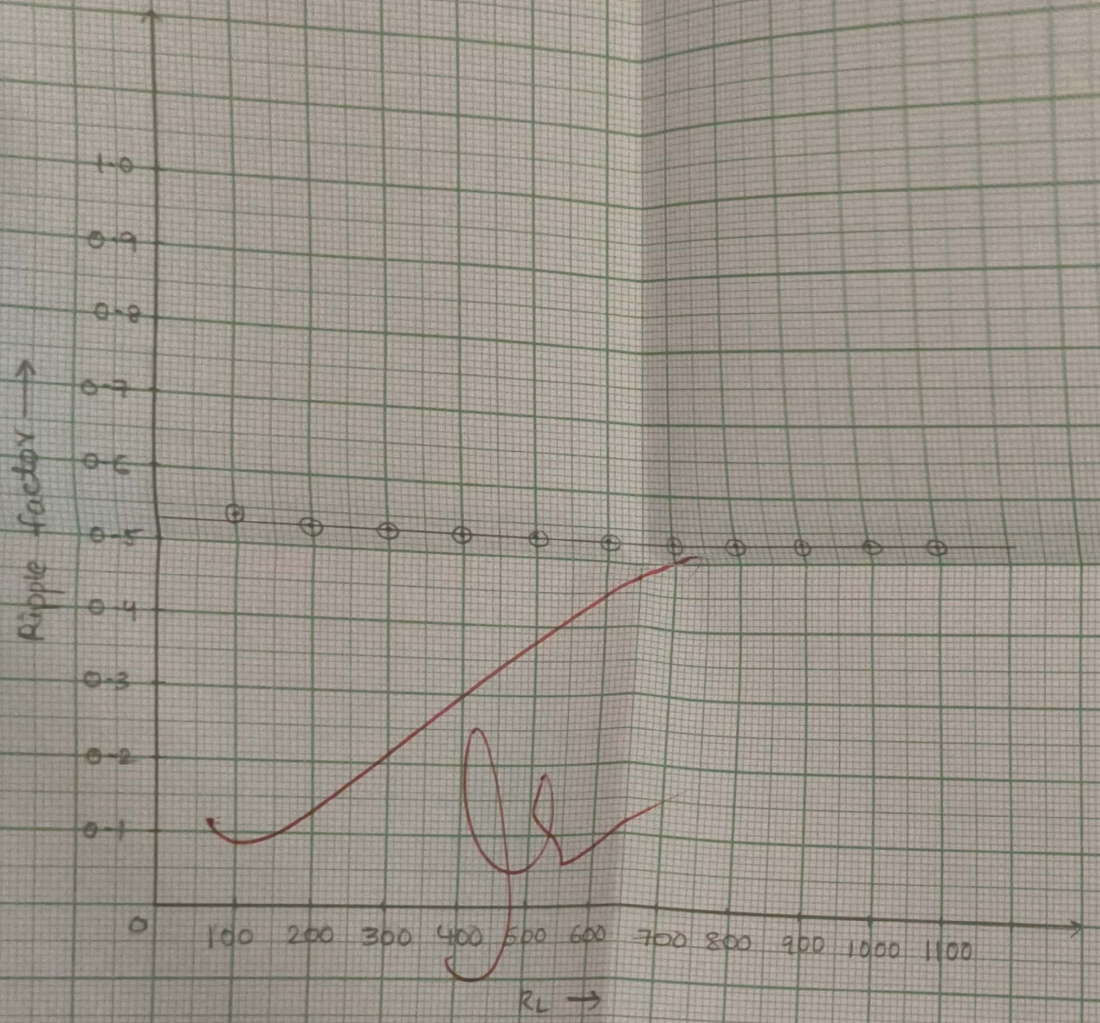
10. **Applications:-**

1. Regulated power supplies.
2. Power circuits.

16/5 Pal

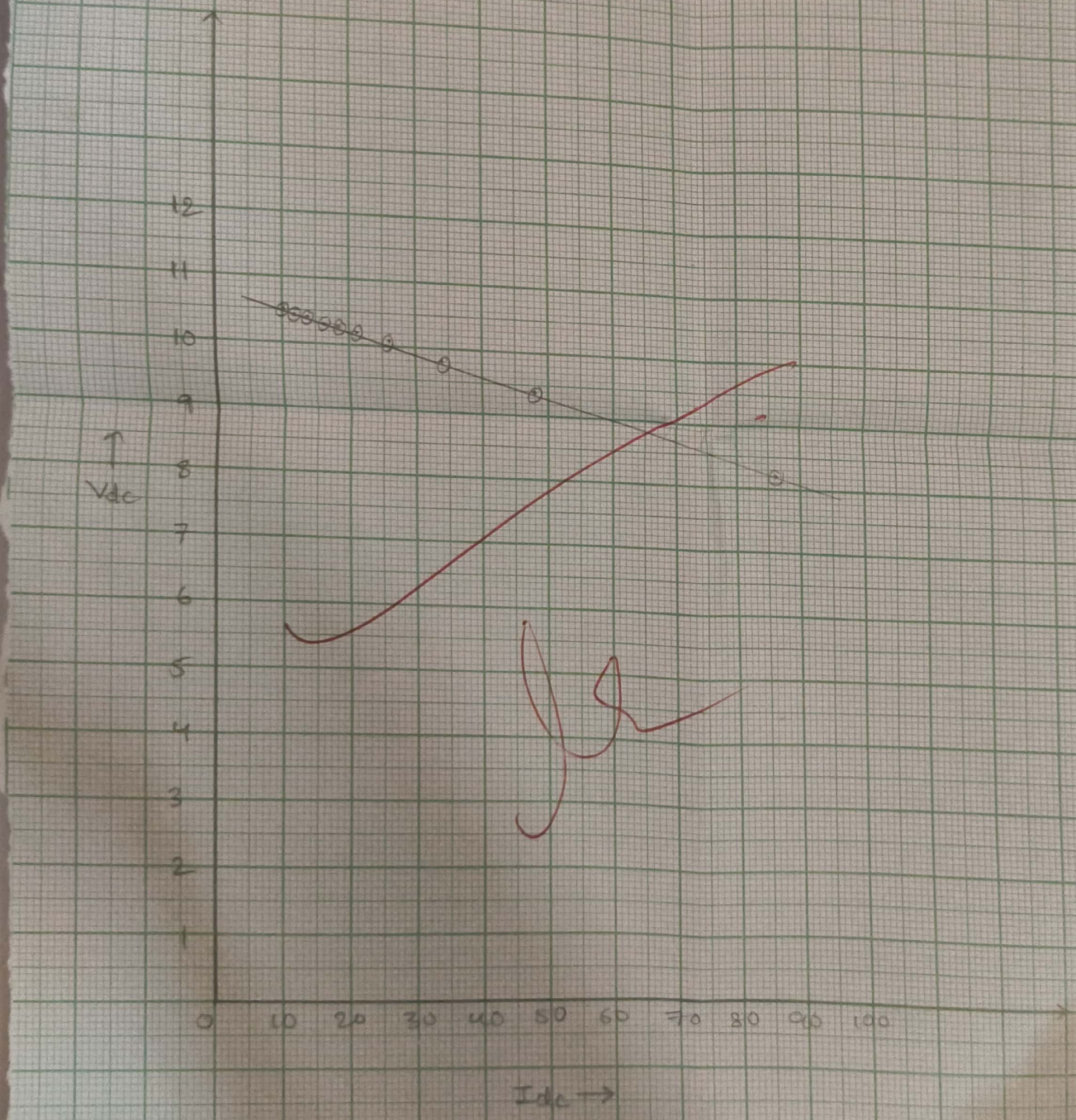
FWR :- RL v/s Ripple factor :-

Scale :
On X-axis: 1 unit = 100 Ω
On Y-axis: 1 unit = 0.1

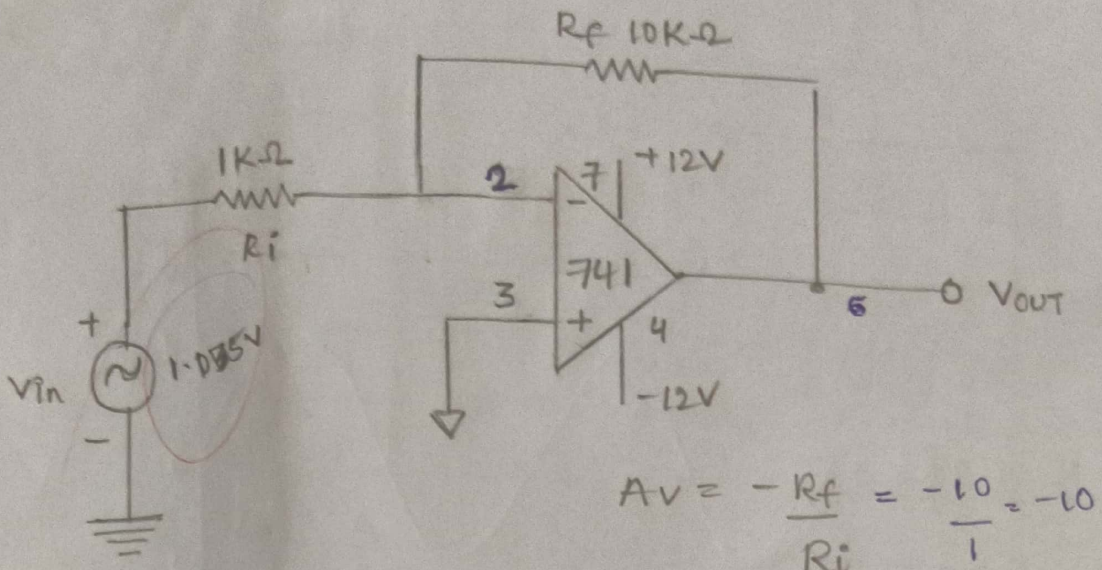


EWR :- Idc v/s Vdc

Scale:-
On X axis: 1 unit = 10 mA
On Y axis: 1 unit = 1V



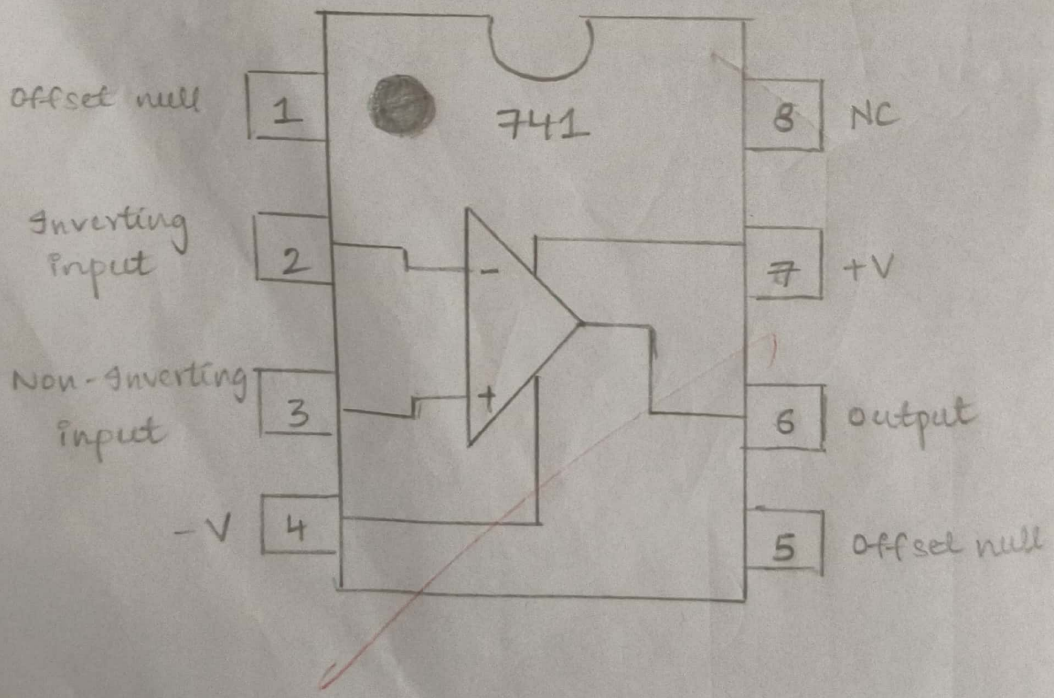
4) CIRCUIT DIAGRAM :-



$$Av = -\frac{Rf}{Ri} = -\frac{10}{1} = -10$$

INVERTING AMPLIFIER

741 Pindiagram :-



INVERTING AMPLIFIERS USING OP-AMP

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1. **Aim:-** Design and realize Inverting amplifier using 741 op-amp.

2. **Apparatus Required:-**

Equipment required:- Cathode Ray Oscilloscope
Function Generator
Bread board
±12 V Supply.

Components required:- Resistors - 1KΩ, 10KΩ.
IC - 741 op-amp.

3. **Theory:-**

5. **Procedure:-**

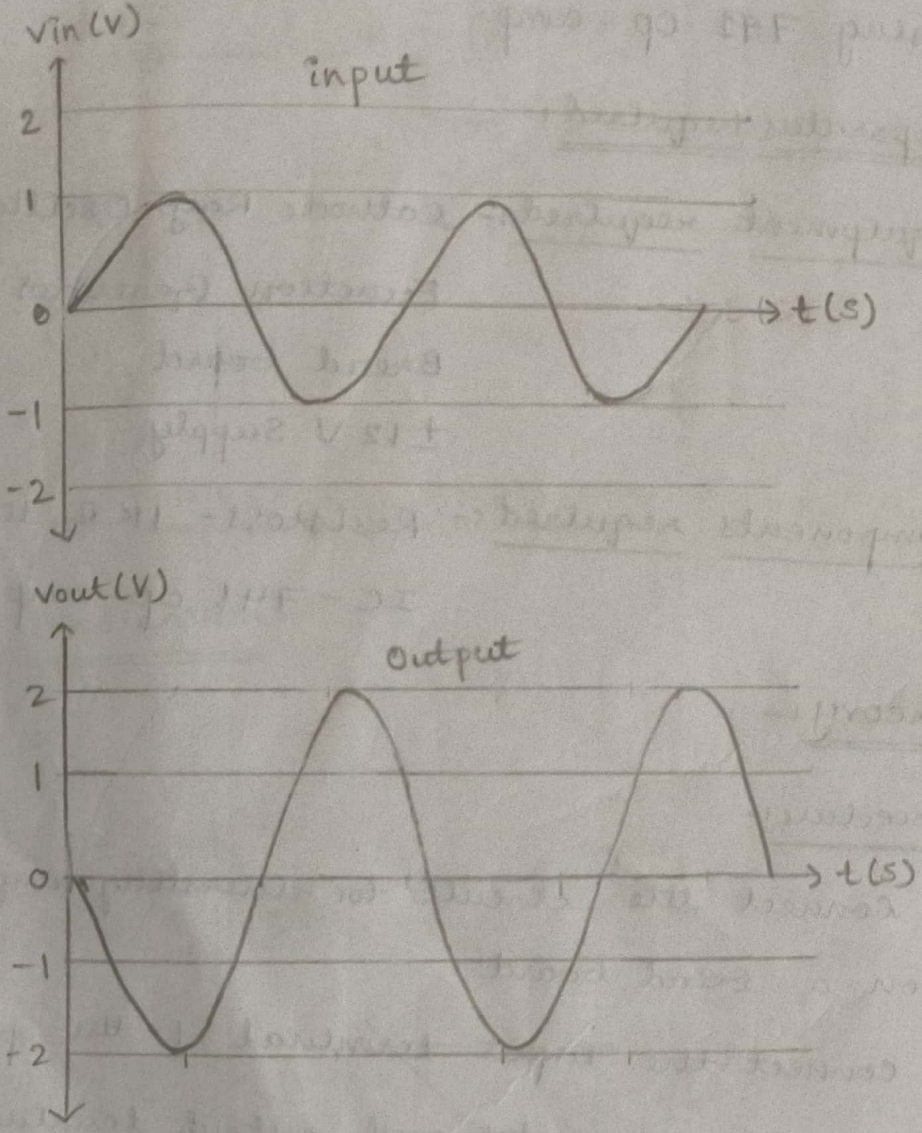
1) Connect the circuit for Inverting amplifier on a bread board.
2) Connect the input terminal of the op-amp to function generator and output terminal to CRO.
3) Feed input from function generator and observe the output on CRO.
4) Draw the input and output waveforms on graph paper.

7. **Precautions:-**

1) Avoid loose circuit connections.

6) OBSERVATION :-

Wave forms :- I/p and o/p waveforms of Inverting op-amp.



S.No	Frequency (Hz)	Voltage peak to peak (Vpp)	
		Input	output
1.	1373	1.030	10.35

$$A = \frac{V_o}{V_{in}} = \frac{10.35}{1.030} = 10.04$$

3) Input and output connections should be properly arranged and grounded.

8. Analysis:-

1) We can observe a 180° phase change between the input and output voltages.

2) The output voltage is amplified by 10 times that of input voltage.

3) Frequency remains constant

9. Result :-

Hence verified and drawn the operation and respective waveforms of inverting amplifier.

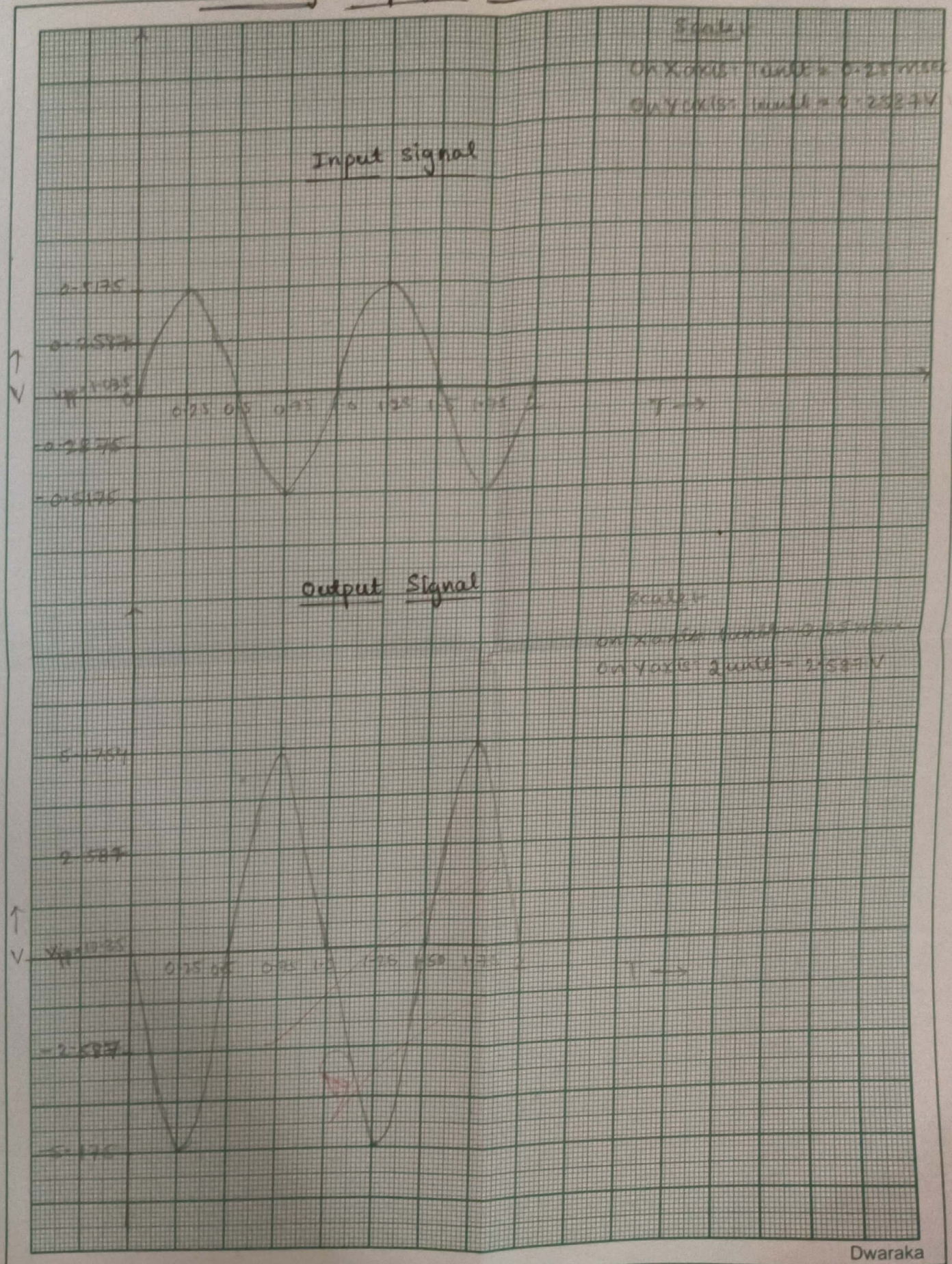
10. Applications:-

1) 741 IC is mostly used to amplify signals of varying frequencies ranging from DC to higher radio frequencies.

2) It is also used in frequency selective amplifiers which filter out signals of unwanted frequencies.

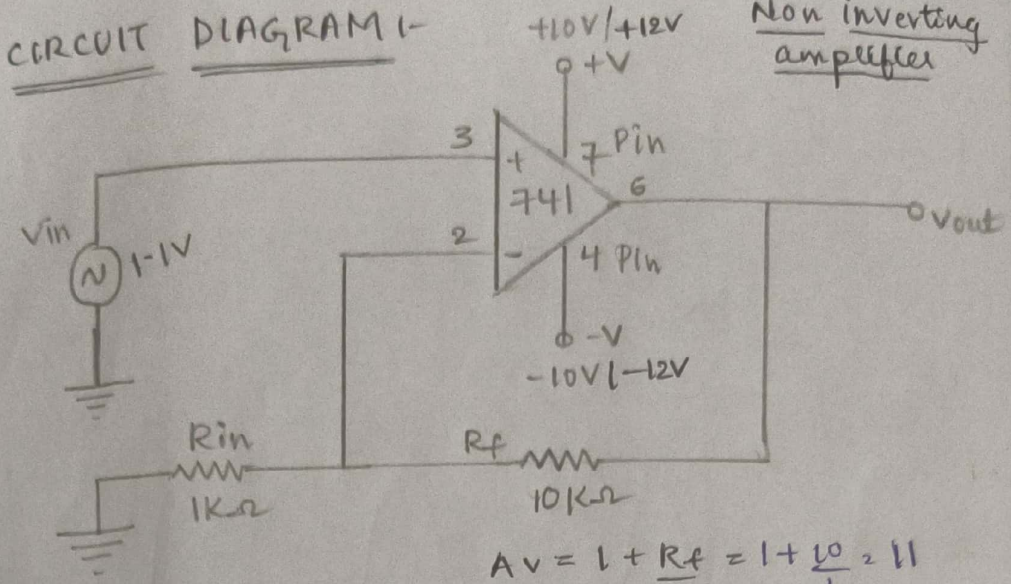
eg. tone control systems in stereo and Hifi systems.

Inverting amplifier using Op-amp



4) CIRCUIT DIAGRAM :-

Non inverting amplifier



$$Av = 1 + \frac{Rf}{Ri} = 1 + \frac{10}{1} = 11$$

741 Pindiagram :-

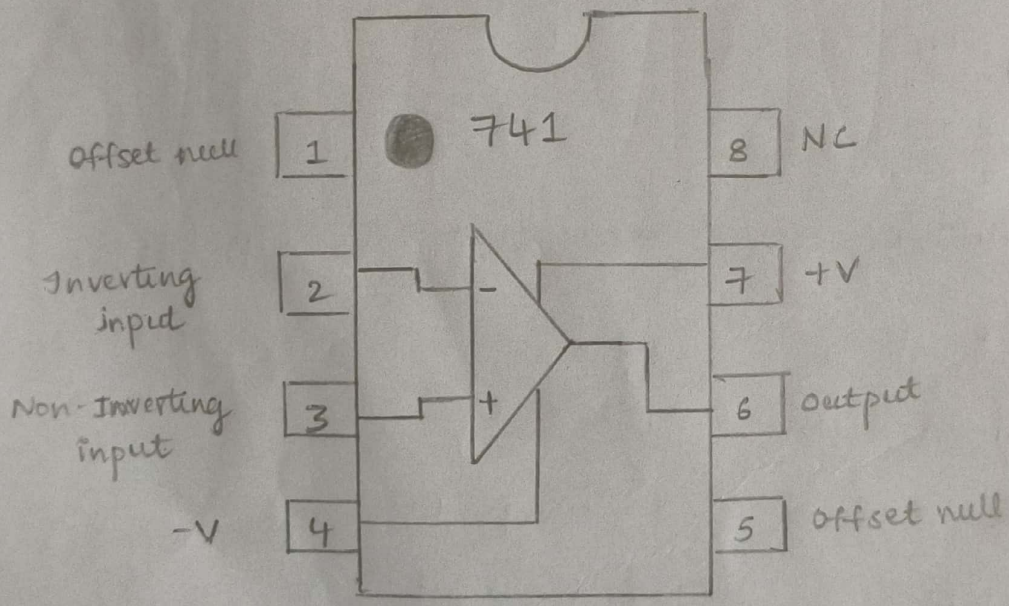


Table :-

S.NO	Frequency (KHz)	voltage peak to peak (Vpp)	
		Input	output
1.	1.371 KHz	1.11 V	12.11 V

$$A = \frac{Vo}{Vin} = \frac{12.11}{1.11} = 10.90$$

NON - INVERTING AMPLIFIERS USING OP - AMP's

2/5/25

1. **Aim :-** Design and realize non - inverting amplifier using 741 op-amp.

2. **Apparatus Required:-**

Equipment required :- Cathode Ray Oscilloscope.
Function Generator.
Bread board.
±12V supply.

Components Required :- Resistors - 1KΩ, 10KΩ
IC - 741 op-amp.

3. **Theory :-**

5. **Procedure :-**

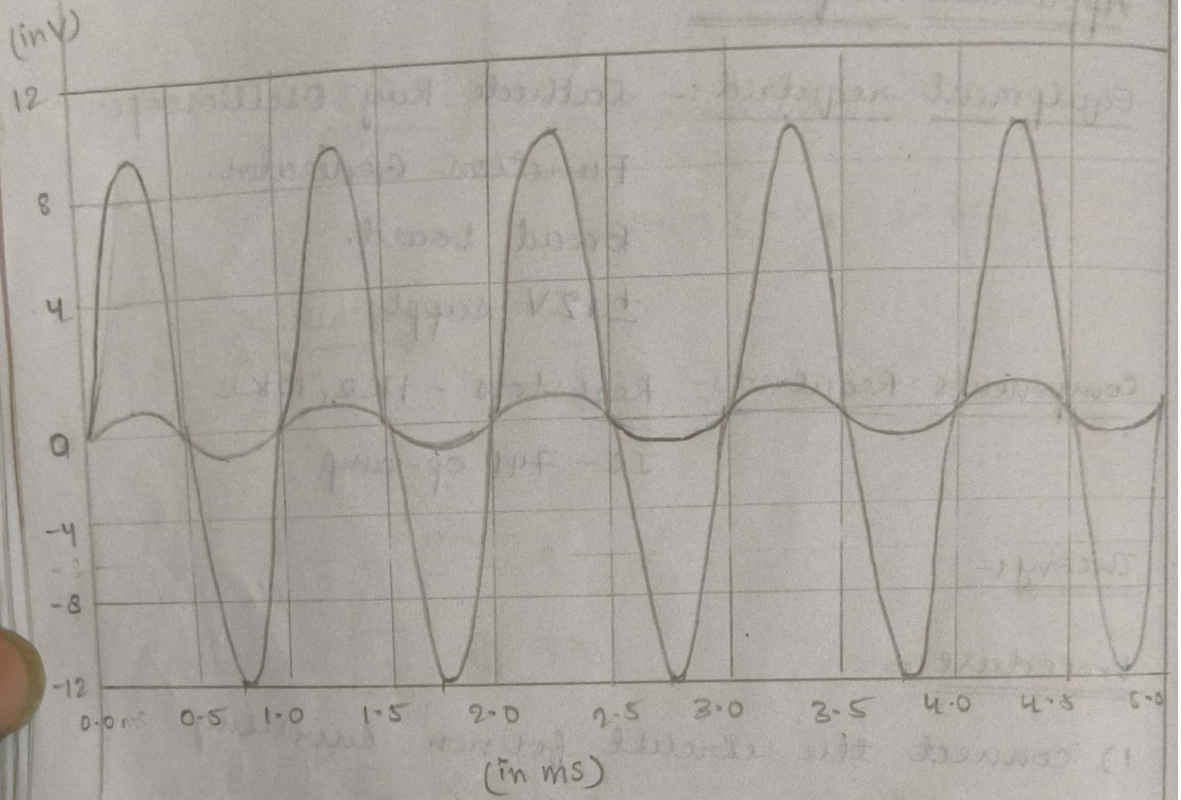
1) connect the circuit for non inverting amplifier on a bread board.
2) connect the input terminal of the op-amp to function generator and output terminal to CRO
3) Feed input from function generator and observe the output on CRO.
4) Draw the input and output waveforms on a graph paper.

7. **Precautions :-**

1) Avoid loose circuit connections.
2) Required power supply should be given.

6) OBSERVATION :-

Waveforms :- Input and output waveforms of non inverting amplifier.



3) Input and output connections should be properly arranged and grounded.

8. Analysis :-

1) Both input and output voltages are in same phase.

2) The output voltage is amplified about 10 times to that of the input voltage.

3) Frequency remains constant.

9. Result :-

Hence verified and drawn the operation and respective waveforms of non-inverting amplifier.

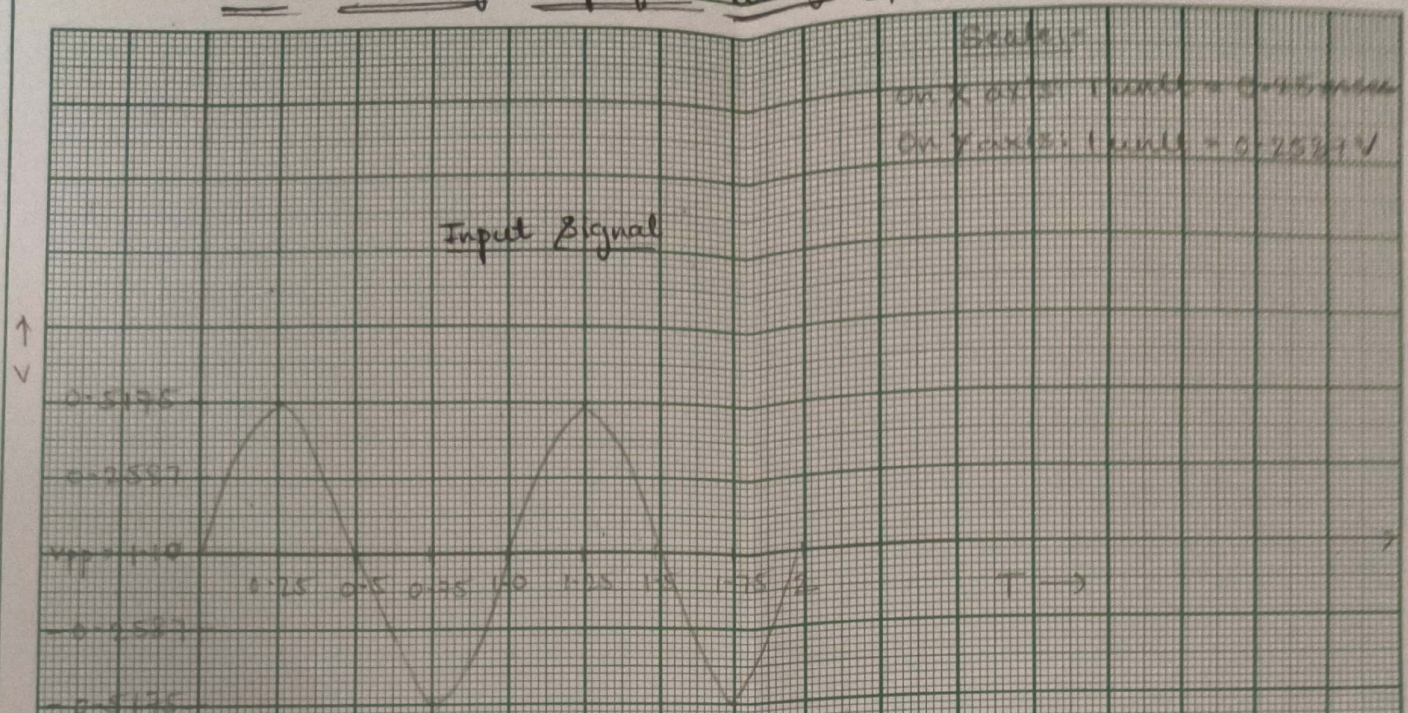
10. Applications :-

1) 741 IC is mostly used to amplify signals of varying frequencies ranging from DC to higher radio frequencies.

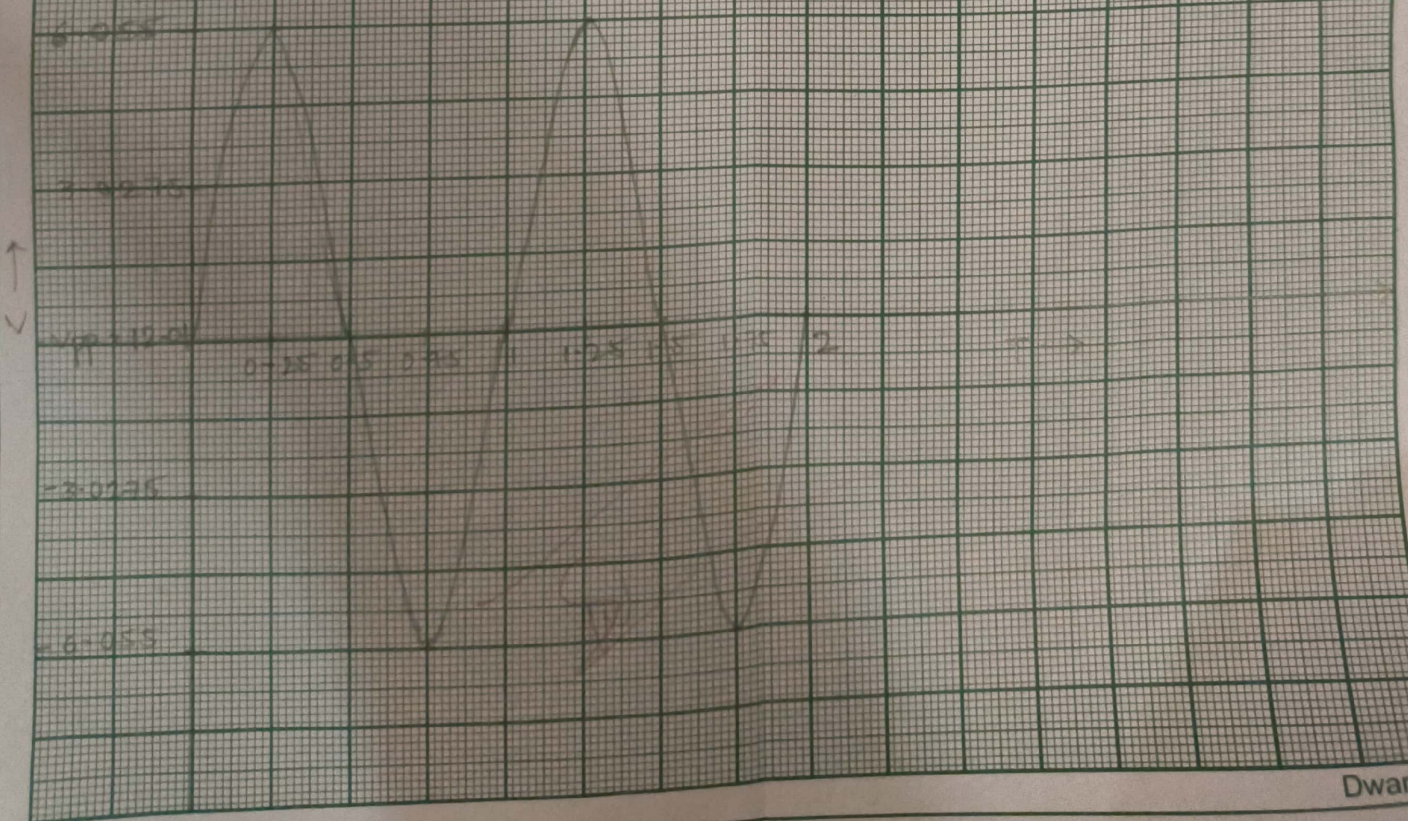
2) It is also used in frequency selective amplifiers which filter out signals of unwanted frequencies, e.g tone control of systems in stereo and wifi systems.

Non- Inverting amplifier using Op-amp

Input Signal



Output Signal



Dwaraka