PRACTICAL

NOTE BOOK

PERSONAL MEMORANDA

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PARTICULARS OF THE EXPERIMENTS PERFORMED

S.No.	EXPERIMENTS	DATE	PAGE	REMARKS
1-	Introduction to basic electronic equipments and devices like CRO, function generator.	8/4/22	1-8	
2 -	To study the V-I characteristics of p-n junction diode and to determine static and dynamic resistance.	22/4/22.	9-14	
3-	To study the V-I characteristics of the zener diode and hence find the dynamic resistance from the characteristics.	29/04/22	15-18	
4-	To determine the voltage regulation of zener diode stabiliser	06/05/22	19-24	
5-	To study and plot the waveform of half-wave and full-wave rectifier with and without capacitance filter.	13/05/22.	25-30	


PARTICULARS OF THE EXPERIMENTS PERFORMED

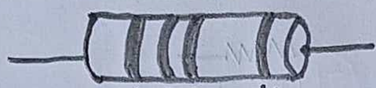
S.No.	EXPERIMENTS	DATE	PAGE	REMARKS
6-	To study and plot the input and output characteristics of common emitter transistor and calculate input and output resistance.	03/06/22	31-38	
7-	To study and plot input and output characteristics of common-base transistor and calculate input and output resistance.	10/06/22	39-44	
8-	To study and plot the FET's characteristics and calculate dynamic resistance (rd), mutual conductance (gm), amplification factor (μ) and pinch off voltage	17/06/22	45-50	

Experiment-1

Aim :- Introduction to basic electronic devices and equipments.

Resistor :-

Carbon Resistor



Resistor

Colour	Value	Multiplier	Tolerance
Black	0	10^0	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold	—	10^{-1}	± 5%
Silver	—	10^{-2}	± 10%

Diode :- P - N
Doped

Signature

Experiment - 1

Aim :- Introduction to basic electronic devices, equipment like ~~CRO, function generator and power~~ supplies, etc.

Theory :- There are mainly two types of components -

(i) Active Components - Are those that deliver or produce energy or power in the form of a voltage or current.

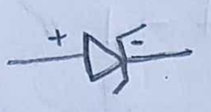
(ii) Passive Components - Are those components that can store or utilize energy in the form of voltage or current.

Some imp. electronic components -

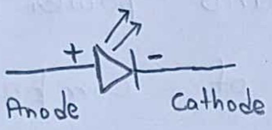
1- Resistors :- It resist the flow of current in a circuit. Value of resistance of a resistor is calculated by using colour band printed on it. Its S.I unit is Ohm (Ω).

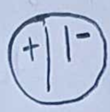
2- Diode :- It allows to flow the current only in one direction i-e for forward bias only. It is made by doping p and n type diode. For a P-N junction diode, the arrow points from p to n direction.

Zener Diode :-



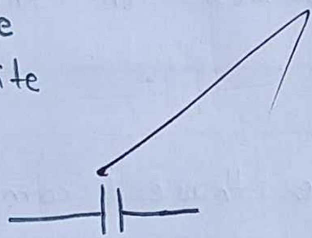
LED :-

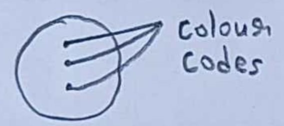




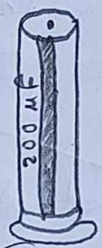
GaAs - Infrared
GaAsP - Amber
SiC - Blue
GaInN - white

Capacitor :-



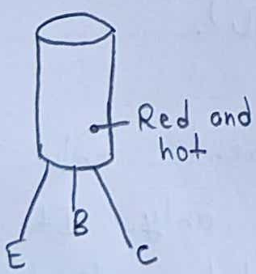


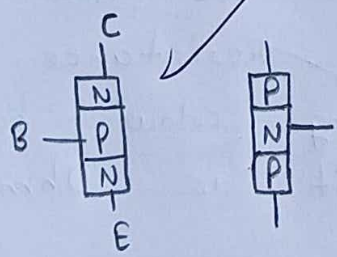
Ceramic capacitor

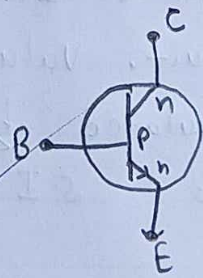


Electrolytic capacitor

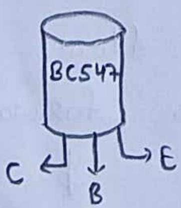
Transistor :-







npn



Signature

3- Zener Diode :- A zener diode also known as breakdown diode, is a highly doped semiconductor device that is designed to operate in reverse direction.

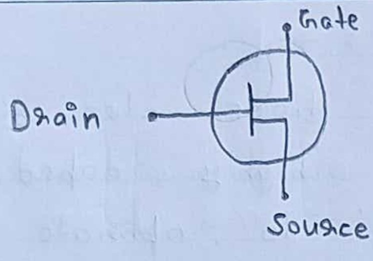
4. LED :- Light Emitting Diode.
It emits light when current is passing through it in the circuit. It works in forward dir^n, and blocks the current in reverse dir^n.

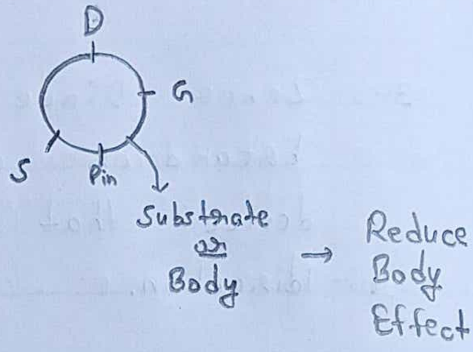
5. Capacitor :- It is a passive element with two terminals. It is used to store energy or charge in it. It is of many types-
Mica , Ceramic, Paper, Film, Electrolytic.

6. Transistor :- It is a three terminal device used to amplify signal or switch electrical signals and power. It consists collector, base and emitter.

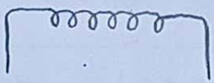
(i) BJT :- The three terminals of a BJT are base, emitter and collector. A very small current flowing between base and emitter can control a larger flow of current between the collector and emitter terminal. It is of two types - PNP and NPN.

FET :-

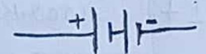


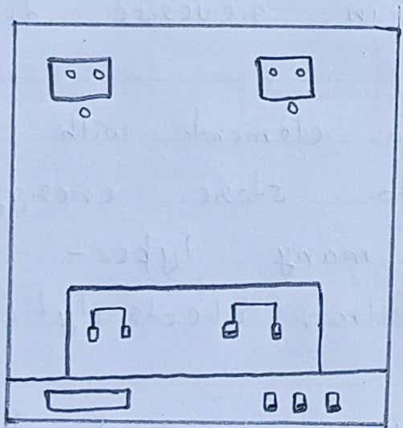


Inductor :-

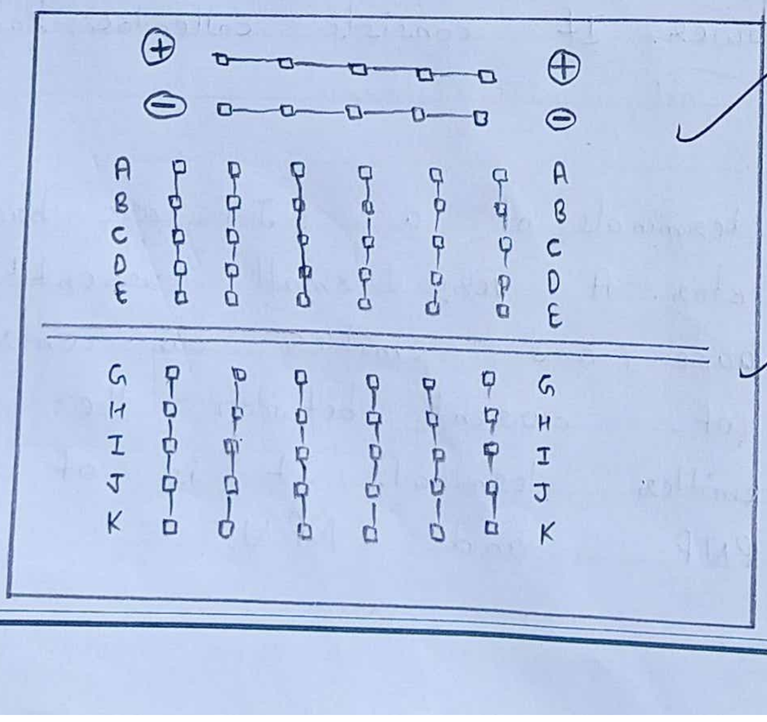


Power supply :-





Bread Board :-



Signature

(ii) FET :- The three terminals are Gate, source and drain. The voltage at the gate terminal can control a current between source and drain. It is used to control the flow of current by generating electric field in a semi-conductor. It consists P- channel and N- channel

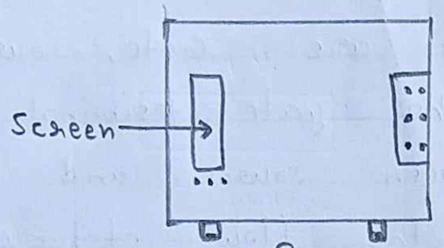
7. Inductor :- Also called choke is a passive, two terminal electrical component that stores energy in a magnetic field when electric current flows through it.

Some Important Equipments :-

1- Power Supply :- It is a electrical device that supplies electric power to an electrical load. It is variable and ranges between 0-30 V in our lab. Red ⊕, Black/Ground ⊖

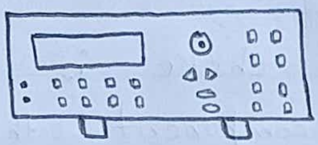
2- Bread Board :- It is a construction base for prototyping of electronics. It have a bunch of tiny holes in it. By using these holes we can easily insert electronic components terminals in it.

CRO :-

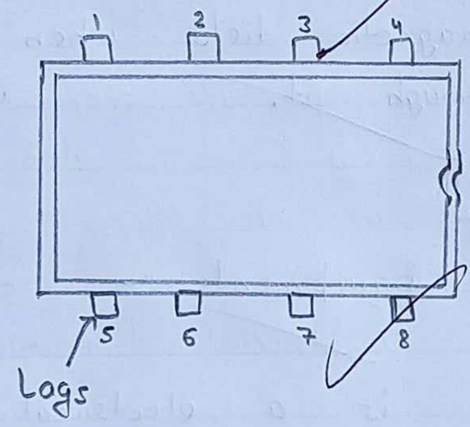


CRO

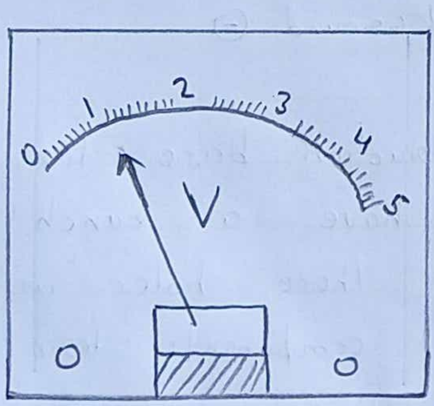
Function Generator :-



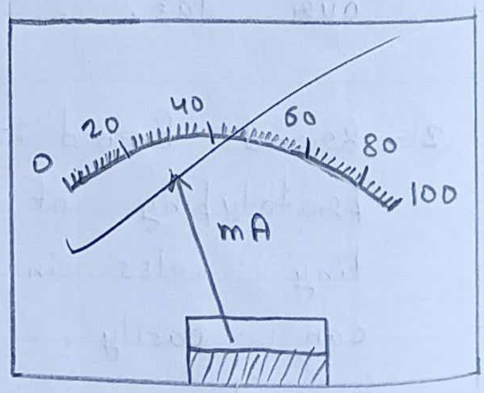
I·C :-



Voltmeter :-



Ammeter :-



Signature

3- CRO :- Cathode Rays Oscilla~~tor~~-scope
It provides accurate time and aplitude measurements of voltage signals over a wide-range of frequencies. It displays the image of signal.

4- Function Generators :- It is a form of signal generator that is able to generate waveforms with common shapes like sine wave, square wave.

5- IC :- Integrated Circuit.
It is a set of electronic circuits on one small flat piece of semi-conductor material, usually silicon.

6- Voltmeter :- It is used to measure potential diff. across two points in electrical circuit. It is always connected in series.

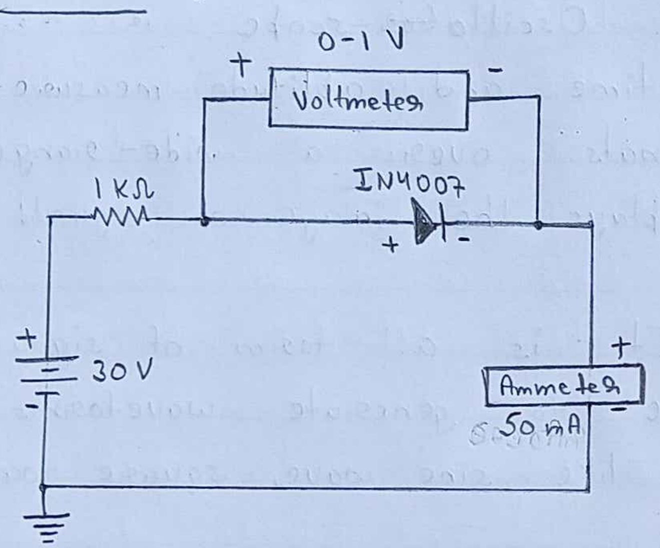
7- Ammeter :- It is used to measure electric current in a circuit. It is always connected in series.

Result :- We are now familiar with electronic components and equipments.

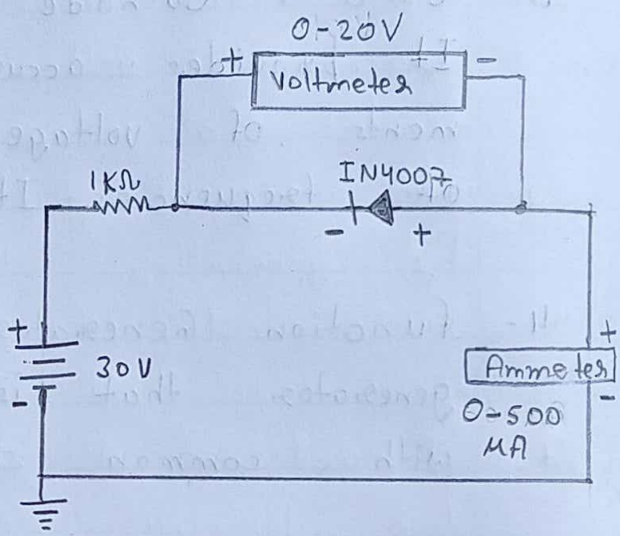
22/04/2022

Experiment-2

Circuit :-



Forward Bias



Reverse Bias.

Observation Table :-

S. No	Forward Bias: Supply Voltage (V)	Forward Bias: Diode voltage(v)	Forward Bias: Diode current (mA)	Reverse Bias: Supply voltage (V)	Reverse Bias: Diode Voltage (V)	Reverse Bias: Diode Current (μA)
1	0.4	0.42	0	1.0	1.0	40
2	0.7	0.52	0.25	2.0	2.0	70
3	1.6	0.60	0.8	3.0	3.0	110
4	2.2	0.62	1.5	4.0	4.0	140
5	3.0	0.64	2.0	4.5	4.5	160
6	4.0	0.66	3.0	5.0	4.8	175
7	6.0	0.68	5.0	6.5	6.5	230
8	8.0	0.72	7.0	8.0	7.5	280
9	11.0	0.74	10.0	9.0	8.5	320
10	15.0	0.76	14.5	10.0	9.5	360

Signature

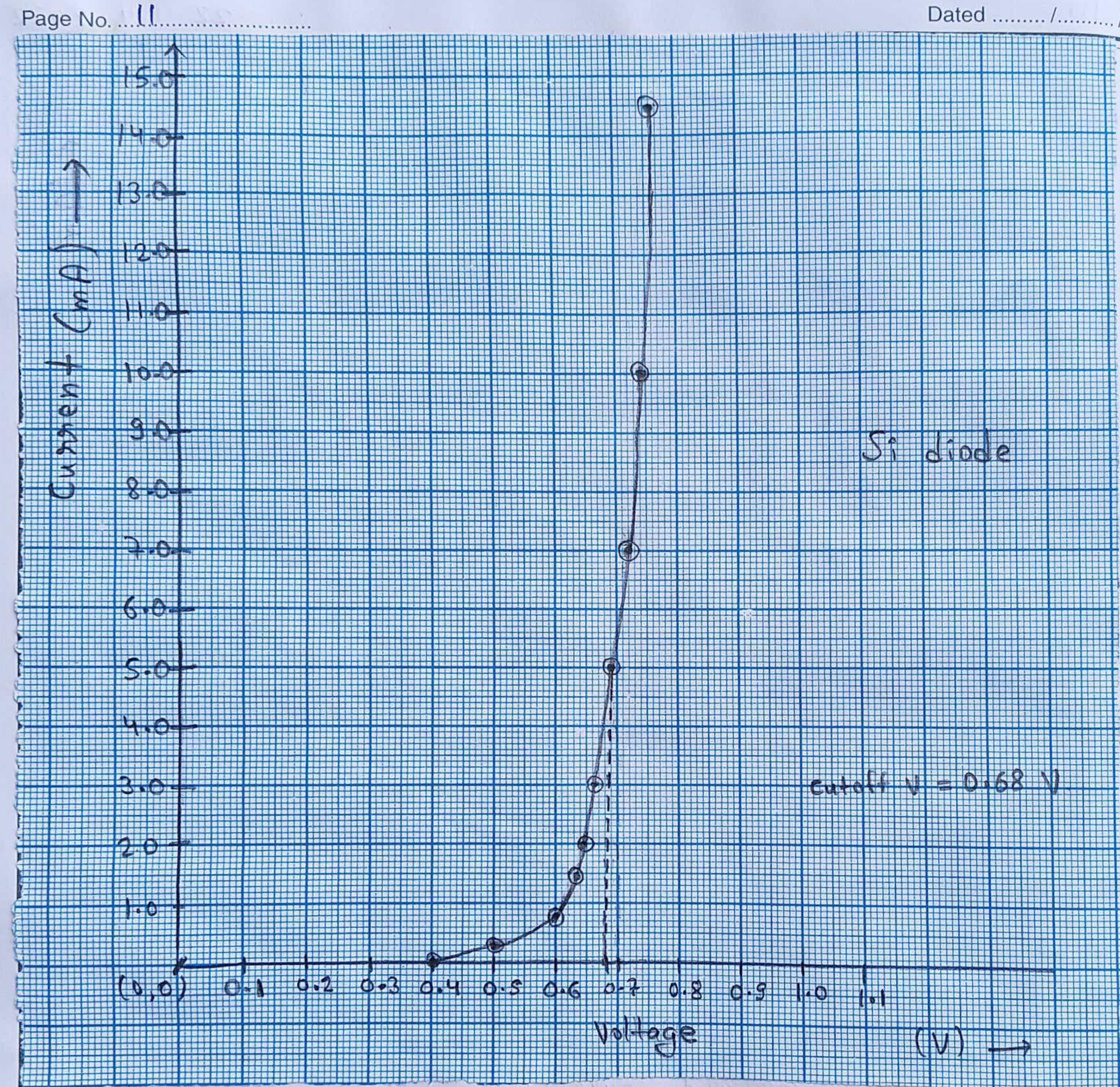
Experiment - 2

Aim :- To study the V-I characteristics of p-n junction diode and to determine static and dynamic resistance.

Apparatus :- Bread board, regulated power supply, diode, resistors of 1 K, Voltmeter (0-10 V), ammeters (0-10 mA, 0-500 μA) and connecting wires.

Theory :- The diode is a device formed from a junction of n-type and p-type semiconductor material.

Forward bias characteristics-
When the p-section of the diode is connected to +ve terminal of a battery and n-section is connected to negative terminal of the battery then junction is said to be forward bias. With increase in bias voltage, the forward current increases slowly in the beginning and then rapidly. At about 0.7 for Si. diode, the current increases suddenly.
The value of forward bias voltage at which the forward current increases rapidly is called cut in voltage or threshold voltage.



Forward bias

$$R_S = \frac{V}{I} = \frac{0.52}{0.25 \times 10^{-3}} \Omega = 2.08 \times 10^{3} \Omega$$

$$R_D = \frac{\Delta V}{\Delta I} = \frac{0.08}{0.55 \times 10^{-6}} \Omega = 0.14 \times 10^{6} \Omega.$$

cutoff voltage = 0.7V.

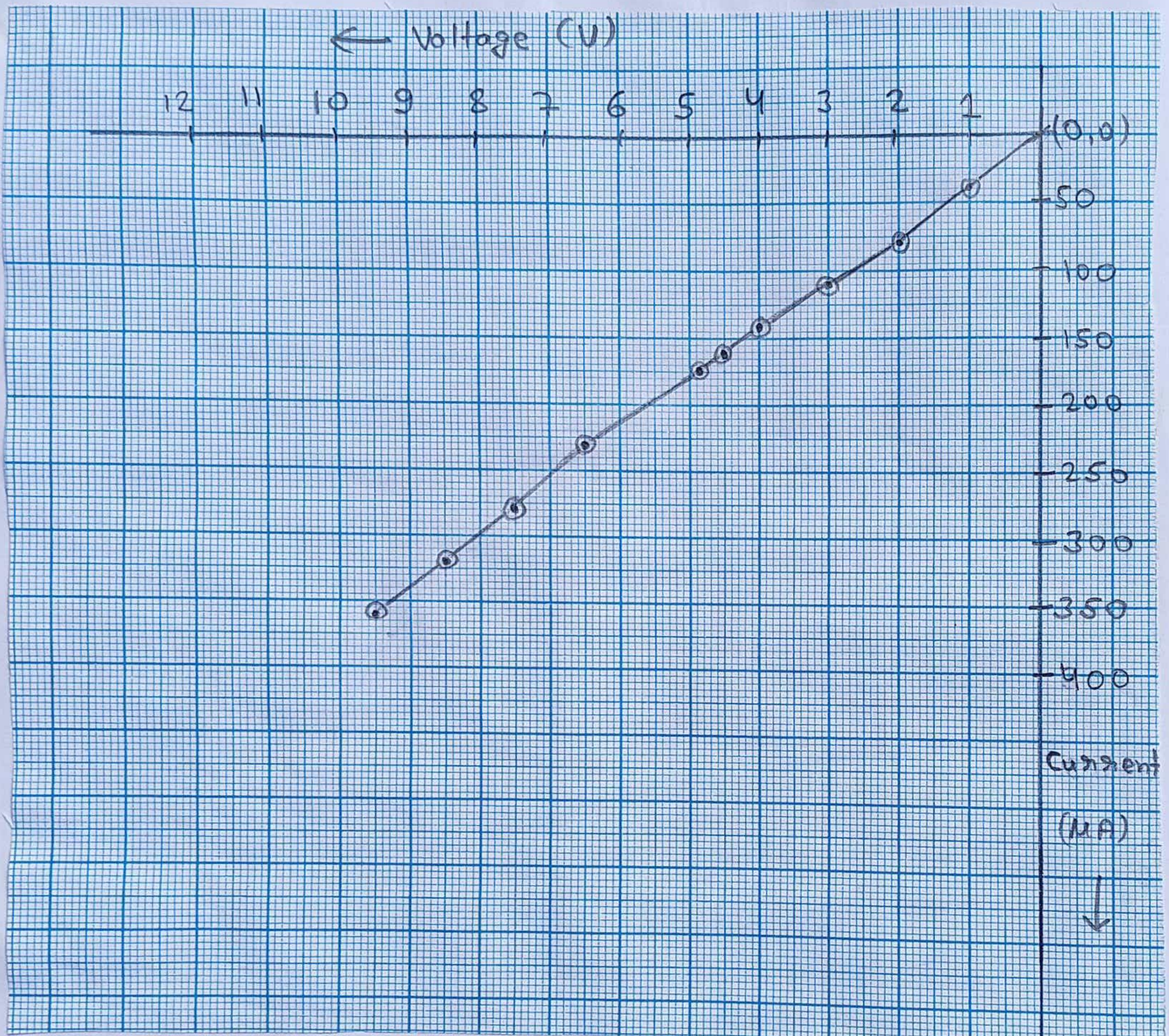
Signature

Reverse bias characteristics-

when the p-section of the diode is connected to -ve terminal of high voltage battery and n-section of the diode is connected to +ve terminal of the same battery, then junction is said to be reverse biased. when reverse bias voltage increases, there is a very small reverse current flow., which remains almost constant with the bias. But when reverse bias voltage increases to sufficiently high value, the reverse current suddenly increases to large value, this voltage called zener breakdown voltage.

Procedure :-

1) Make the circuit as shown in the diagram.
2) Note the least count of ammeter and voltmeter.
3). Now, vary the regulated power supply voltage in very small range and observe the deflection in voltmeter.
4) Vary supply voltage and take about 10 readings and note down them in tabular form which includes supply voltage, voltmeter reading, ammeter reading.
5) Now, change the circuit according to the reverse bias and note down about 10 readings and then do calculations and plot graph.



Reverse bias

$$R_S = \frac{V}{I} = \frac{1}{40\times10^{-6}} = 2.5\times10^{4}\,\Omega$$

$$R_D = \frac{\Delta V}{\Delta I} = \frac{1}{30\times10^{-6}} = 3.3\times10^{4}\,\Omega$$

Signature

Result :-

In forward bias; Static Resistance = $2.08 \times 10^3 \ \Omega$

Dynamic Resistance = $0.14 \times 10^6 \ \Omega$.

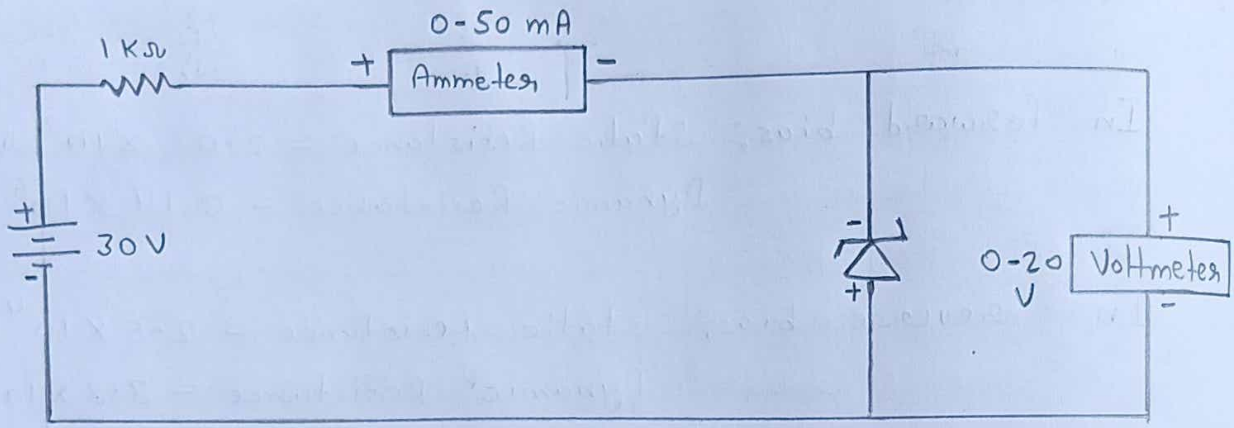
In reverse bias; static Resistance = $2.5 \times 10^4 \ \Omega$

Dynamic Resistance = $3.3 \times 10^4 \ \Omega$.

Precautions :-

1) The connections should be neat, clean and tight.
2) Take readings carefully.
3) Turn off the power supply when not in use.

Experiment - 3



Circuit Diagram

Observation Table :-

S. No.	Supply Voltage (V)	Diode voltage (V)	Diode Current (mA)
1	4	4	0
2	6.2	6	0
3	7.0	6	0.5
4	8.0	6	1.5
5	9.0	6	2.5
6	10.0	6	3.5
7	11.0	6	4.5
8	12.0	6	5.5
9	13.0	6	6.5
10	14.0	6	7.8

Signature

Experiment - 3

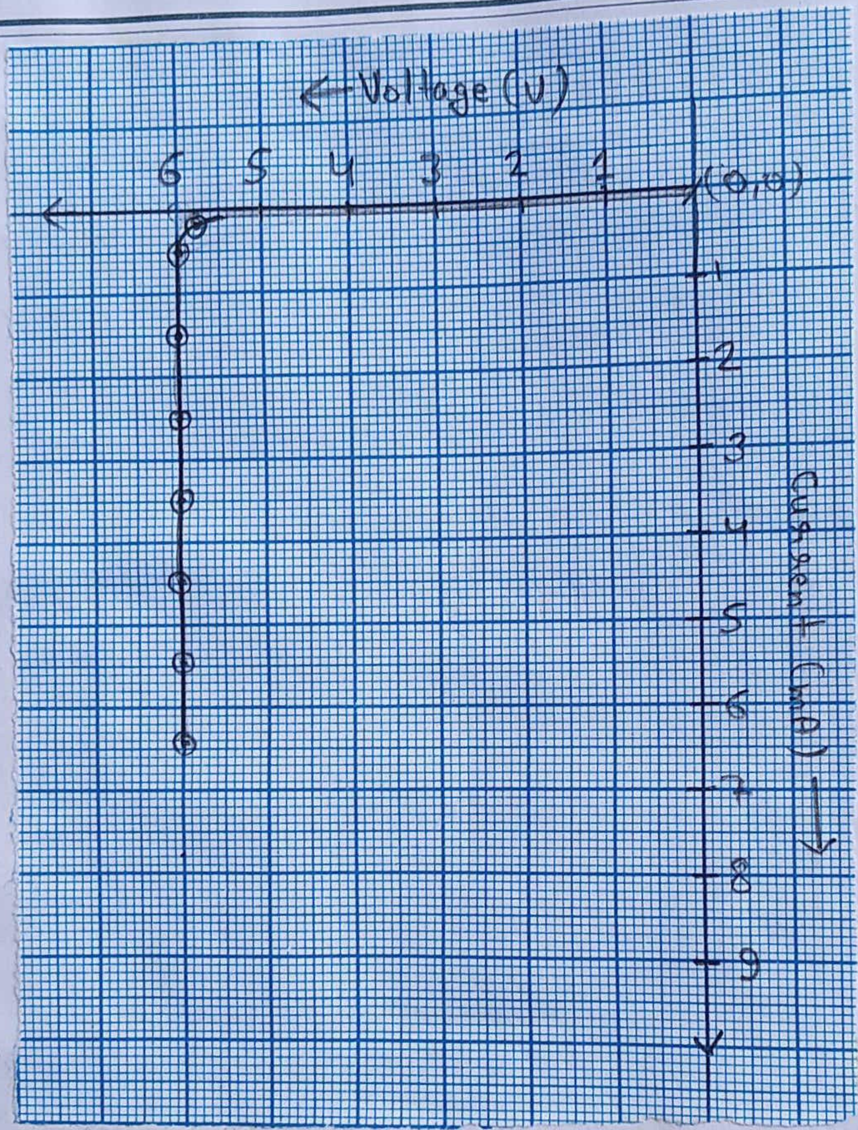
Aim :- To study the V-I characteristics of the zener diode and hence find the dynamic resistance from the characteristics.

Apparatus :- Breadboard, zener diode, resistor (1KΩ), power supply (0-30V), voltmeter (0-20V), ammeter (0-50 mA), connecting wires.

Theory :- when a reverse voltage is applied across the diode, initially a small reverse saturation current flows across the diode.
Zener diode is heavily doped than the normal p-n diode. Hence it has very ~~thick~~ thin depletion region.
As the reverse voltage is increased, at a certain value of reverse voltage, the junction will breakdown and large reverse current start to flow through the device. This breakdown is called zener breakdown and voltage is called zener voltage.

Procedure :-

1) We first construct the circuit as shown in fig.
2) Note the least count of ammeter and voltmeter.
3) Now, we turn on the supply and start increasing the voltage till there is some reading in the



Calculations :-

$$R_D = \frac{\Delta V}{\Delta I} = \frac{\cancel{20}^{4}}{0.\cancel{5}\times10^{-3}} = 4\times10^{4}\ \Omega = 40K\ \Omega$$

ammeter for current.

4) Then we note that reading. Now we vary the input voltage by slowly increasing voltage and take the corresponding current readings.

5) We take about 10 readings and construct a V vs I graph.

6) This graph gives us the I-V characteristics of zener diode.

7) The slope of the curve at any point gives the dynamic resistance at that voltage.

Result :-

The dynamic resistance of given zener diode is = 40 KΩ

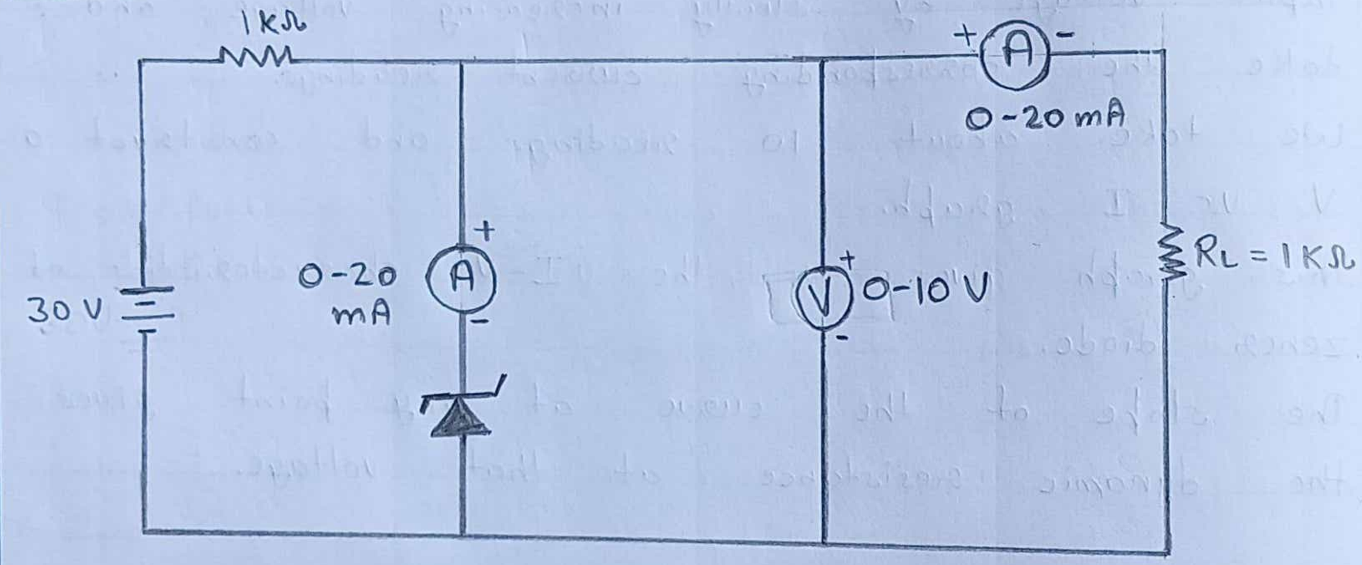
Precautions :-

1) The connections should be tight otherwise fluctuation in voltage and current will happen.
2) Excessive flow of current may damage the diode.
3) Take the readings carefully.
4) Handle given instruments in a proper way.

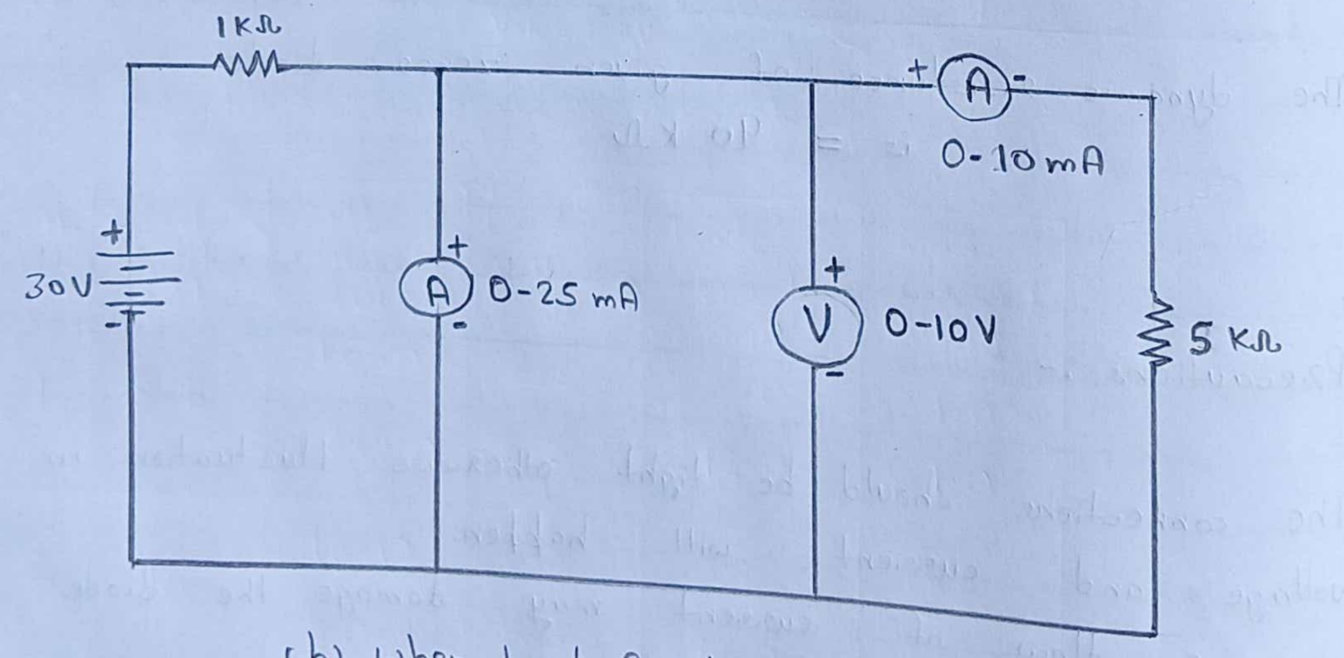
Experiment - 4

Aim :- To determine the voltage regulation of zener diode.

Circuit :-



(a) when Load Resistance is fixed.



(b) when Load Resistance is Variable

Experiment-4

Aim :- To determine the voltage regulation of zener diode stabiliser

Apparatus :- Zener diode, resistor of 1 K (two nos), voltmeter (0-10 V), ammeter (0-20 mA), regulated power supply (0-30V).

Theory :- A voltage regulator is an electronic circuit that provides a stable DC voltage independent of the load current, temp. and AC line voltage variations. A zener diode of breakdown V_z is reverse connected to an input voltage source V_1 across a load resistance R_L and a series resistance R_s. The voltage across the zener will remain steady at its break down voltage V_z for all the values of zener current I_z as long as the current remains in the breakdown region. Hence a regulated DC output voltage is obtained across R_L.

Procedure :-

(i) When load resistance is fixed-

- Make the diagram according to circuit diagram
- Turn on the supply and vary the voltage such that zener is on.
- Note down the voltmeter and ammeter readings for various DC voltage.

Case I :- Load Resistance is fixed

$R_L = 1\ K\Omega$

S. No	Supply Voltage (V)	Load Voltage (V_L)	Diode current I_Z (mA)	Load Current I_L (mA)
1	2.0	1.0	0.0	0.5
2	4.0	2.0	0.0	1.5
3	8.0	4.0	0.0	3.5
4	10.0	5.0	0.0	4.5
5	14.0	6.5	0.5	6.0
6	16.0	6.5	2.5	6.0
7	18.0	6.5	4.5	6.0
8	20.0	6.5	6.5	6.0
9	22.0	6.5	9.0	6.0
10	24.0	6.5	11.0	6.0

$V_{NL} = 6.6V$

Case II :- Load Resistance is Variable.

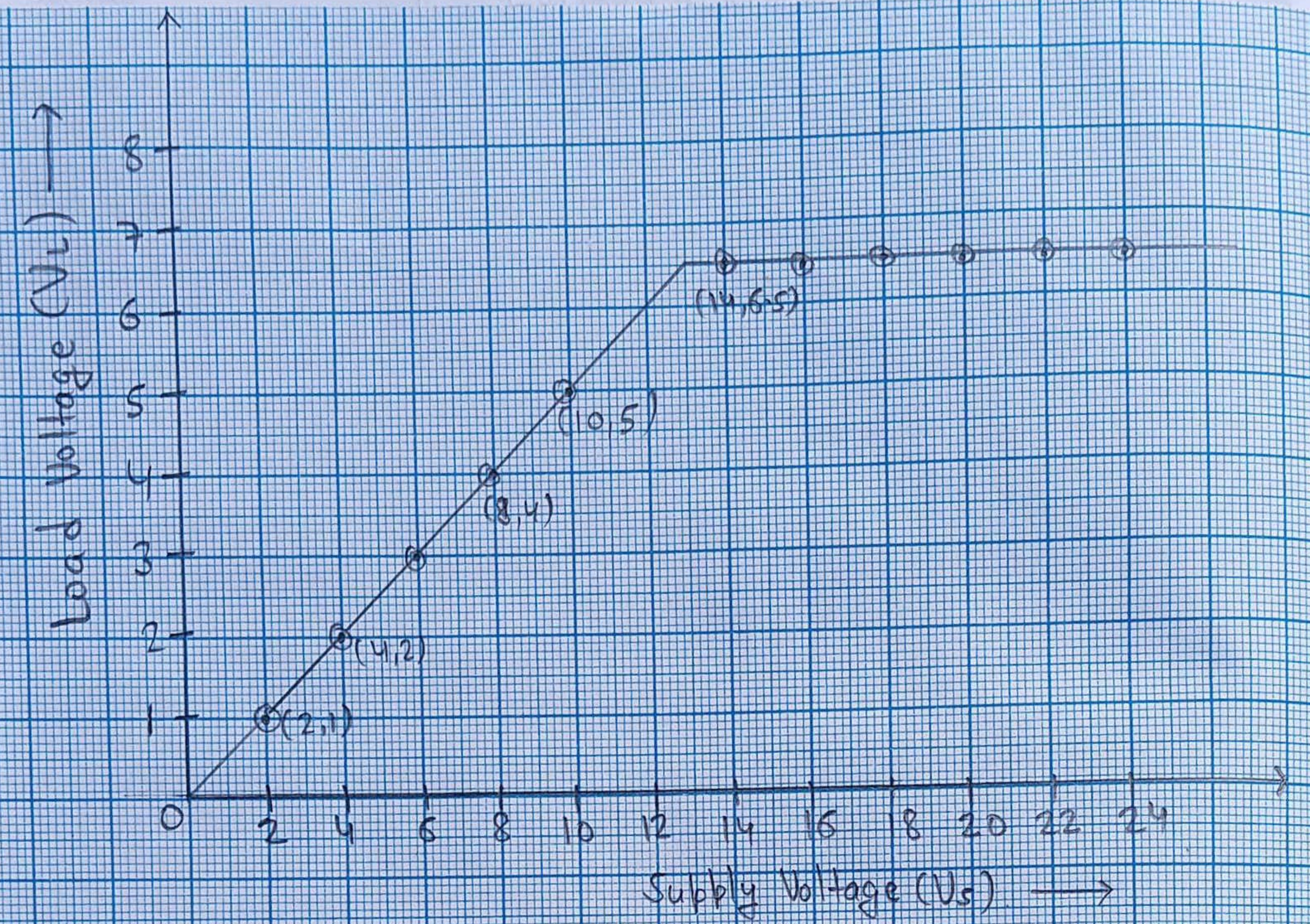
S. No	Load Resistance (KΩ)	Supply Voltage (V)	Load Voltage (V)	Diode current (mA)	Load current (mA)
1	5.6	16.0	6.5	8.0	1.0
		20.0	6.5	12.0	1.0
2	10	16.0	6.5	8.5	0.5
		20.0	6.5	13.0	0.5

$V_{NL} = 6.6V$

Signature

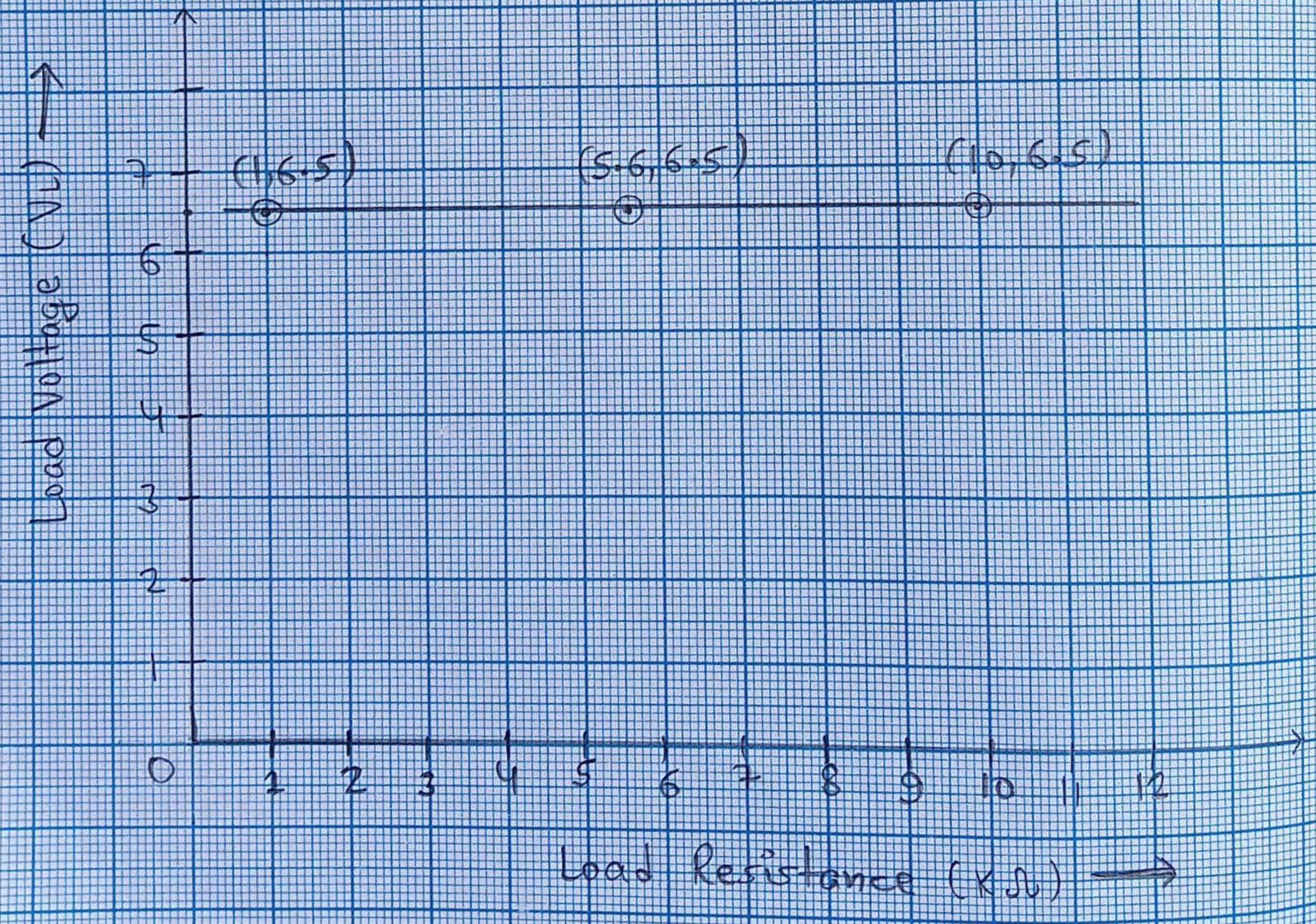
Case I :- Load Resistance is fixed

S. No
1
2
3
4
5
6
7
8
9
10



Case

S. No
1
2



- Calculate the voltage regulation

(ii) when the load resistance is variable -
- Fix the value of supply voltage
- Note the reading of load, current and voltage from different resistors starting from the one which has been lower resistance value.
- Observation table is prepared.

Finally, the result is calculated using the observation table.

Precautions :-

1) Circuit must be made strictly according to circuit diagram.
2) Power supply should be given only when reading is to be taken.
3) Diode used ~~no~~ should be zener.
4) Supply voltage must be increased in regular interval.

Calculations :-

Case I :- For Fixed Load Resistance

$V_{NL} = 6.6\ V$

$V_{FL} = 6.5\ V$

NL → No Load
FL → Full Load

$$\text{Regulation Factor} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

$$= \frac{6.6 - 6.5}{6.5} \times 100$$

$$= 1.5\ \%$$

Case II :- For Variable Load Resistance.

$V_{FL} = 6.5\ V$

$V_{NL} = 6.6\ V$

$$\text{Regulation Factor} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

$$= \frac{6.6 - 6.5}{6.5} \times 100$$

$$= 1.5\ \%$$

Signature

Result :-

We get voltage regulation factor as 1.5 %

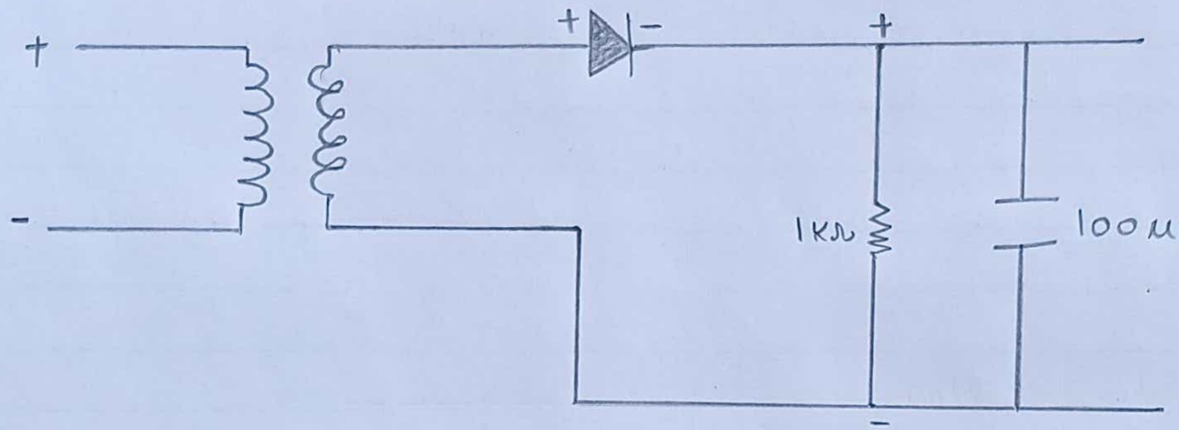
The breakdown voltage of zener diode is 6.5 V.

Experiment - 5

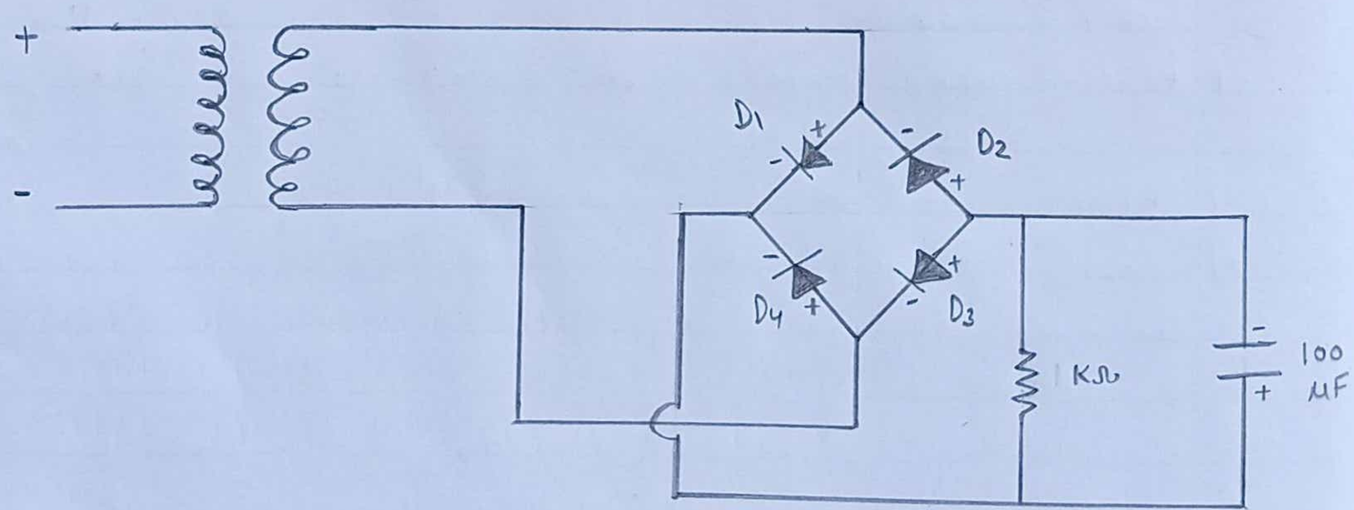
Aim :- To study and plot the waveform of half wave and full wave rectifier with and without capacitor filter.

Circuit Diagram :-

(i) Half-Wave Rectifier :



(ii) Full-wave Rectifier :



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Experiment - 5

Aim :- To study and plot the waveform of half-wave and full wave rectifier with and without capacitance filter.

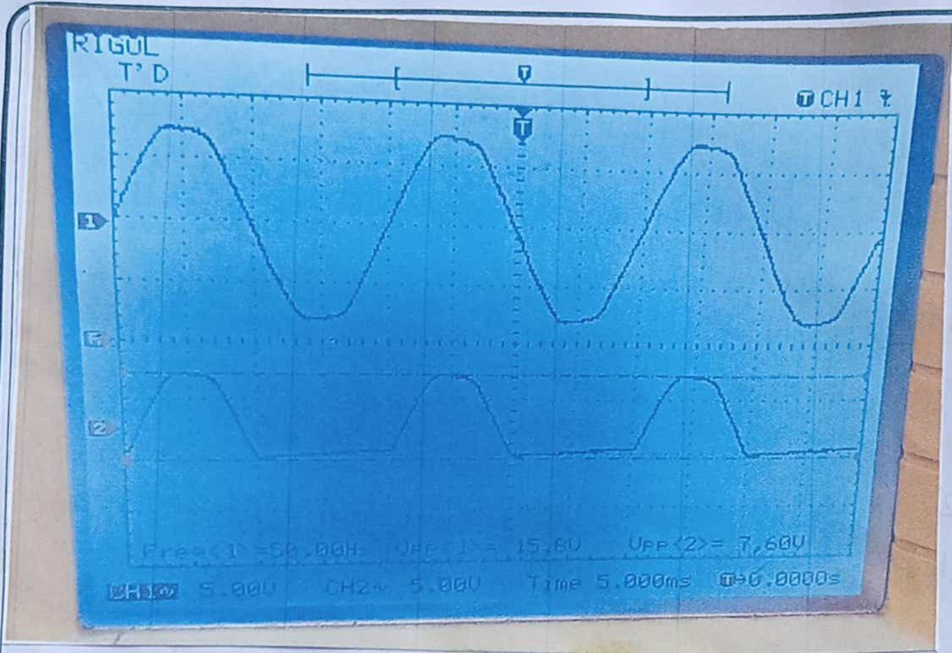
Apparatus :- Diode - 4 nos, resistor of 1 KΩ, supply voltage 230 V A.C, transformer 12 V, CRO, bread-board, connecting wires.

Theory :-

In half-wave rectifier, firstly a high ac voltage is applied to the primary side of the step down transformer and we will get a low voltage at the secondary winding which will be applied to the diode.

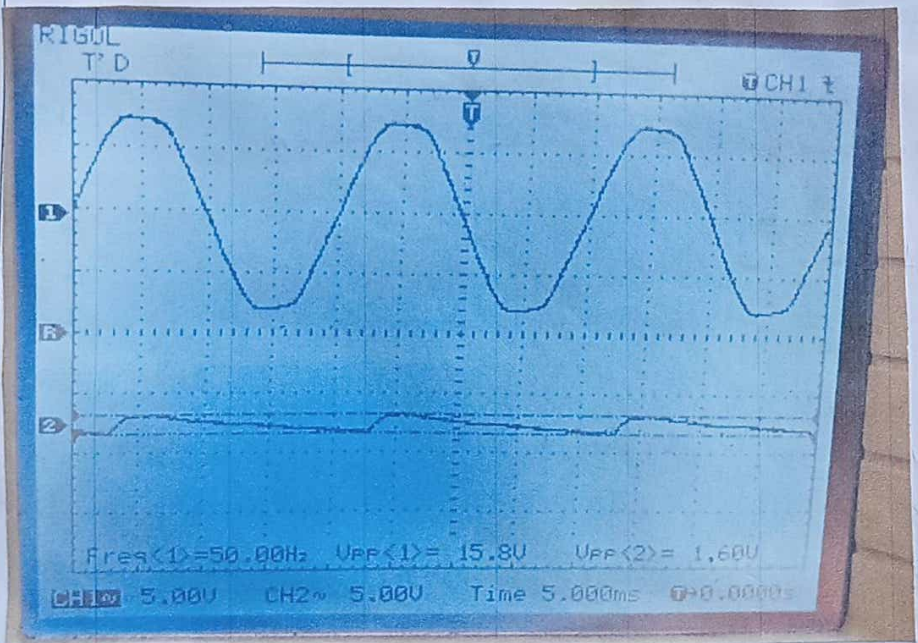
During the positive half cycle of the AC voltage, the diode will be forward biased and current flows through the diode. During the negative half cycle of the A.C voltage, the diode will be reversed and the flow of current will be blocked. The final output voltage waveform on the secondary side (DC) is shown in the graph.

Filters are components used to convert pulsating DC waveforms into constant DC waveforms. They achieve this by suppressing the DC ripples into the waveform. A capacitor is most commonly used as a



Half-Wave

Without Capacitor



With Capacitor

C = 100 µF

a) Input Frequency = 50 Hz
b) Input Voltage = VPP/2 = 15.8/2 = 7.9 V
c) Output Voltage (without capacitor) = 7.60 V
d) Output Voltage (with capacitor) = 1.60 V
e) Output frequency = 50 Hz

Signature

filter in half-wave rectifier.

In a full-wave Bridge rectifier, four individual rectifying diodes connected in a closed loop bridge configuration to produce the desired output.

During the negative half cycle of the supply, diode D_2 and D_4 conducts in series, but diodes D_1 and D_3 switch off as they are now reverse-biased. The current flowing through the load is the same dirn as before.

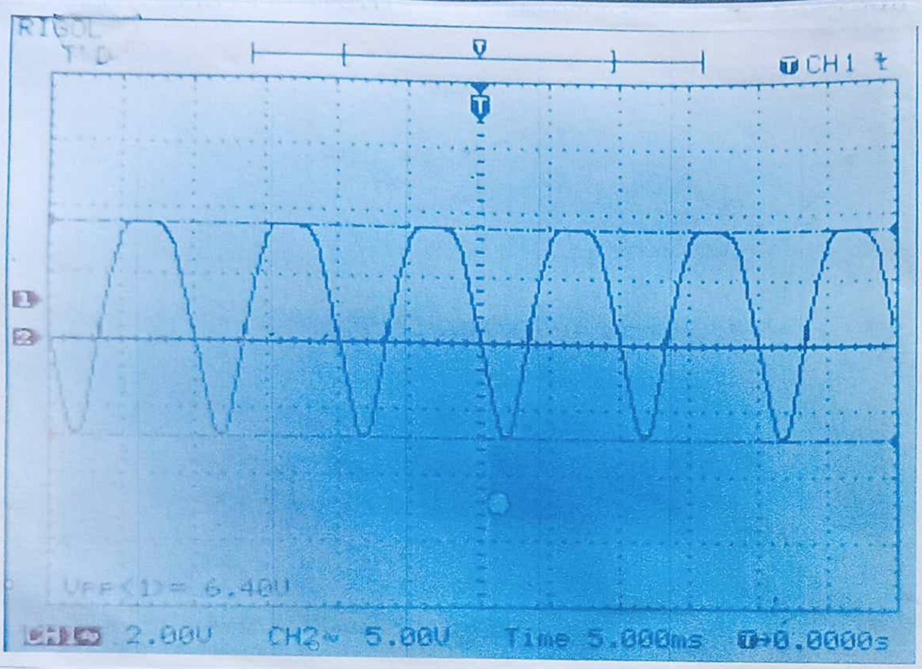
During the positive half cycle as current flowing through the load is unidirectional so the voltage developed across the load is also unidirectional, the same as for the previous two diodes.

Precautions :-

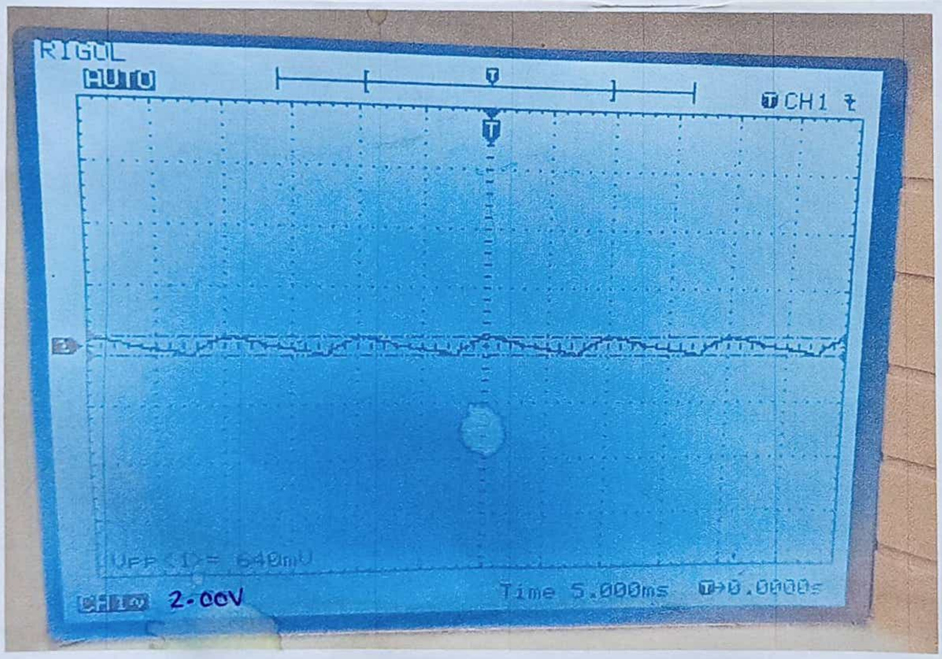
1) Connections should be verified before clicking the run button
2). The resistance to be chosen should be in KΩ range.
3) Best performance is being obtained within 50 Hz to 1 MHz.

Full-Wave

Without Capacitor



With Capacitor



(a) Input frequency = 50.1 Hz
(b) Input Voltage = $V_{PP}/2$ = 6.40/2 = 3.20 V
(c) Output Voltage (without capacitor) = 2.0 V
(d) Output Voltage (with capacitor) = 640 mV
(e) Output frequency = 100.2 Hz

Signature

Dated .... /.......... /..............

Result :-

(i) Half-wave Rectifier -

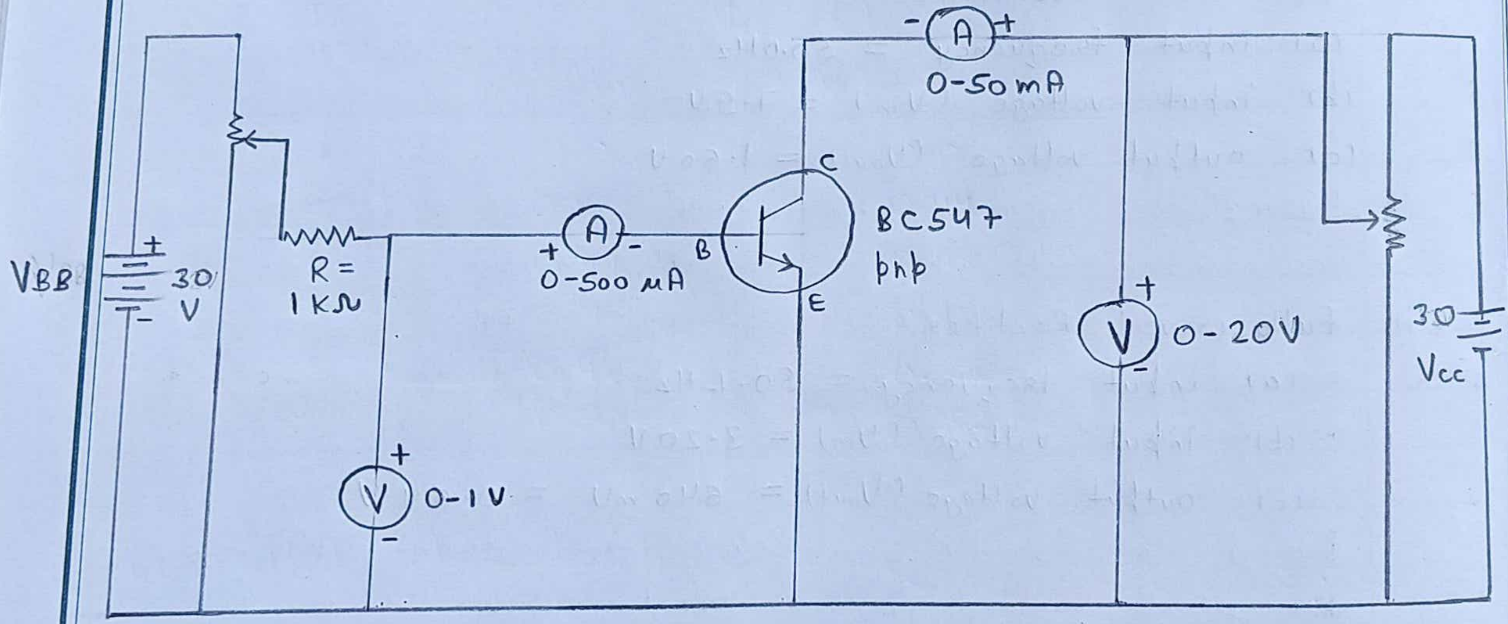
(a) input frequency = 50.0 Hz
(b) input voltage (V_{in}) = 7.9 V
(c) output voltage (V_{out}) = 1.60 V

(ii) Full-wave Rectifier -

(a) input frequency = 50.1 Hz
(b) input voltage (V_{in}) = 3.20 V
(c) output voltage (V_{out}) = 640 mV = 0.64 V

Experiment-6

Circuit Diagram :-



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Experiment - 6.

Aim :- To study and plot the input and output characteristics of common emitter transistor and calculate input and output resistance.

Apparatus :- Transistor, resistor of 1 KΩ, voltmeter (0-1V, (0-20V), ammeter (0-500 μA, 0-50 mA), two power supplies, bread board, connecting wires.

Theory :- In common-emitter transistor, emitter terminal of transistor is common between the input and output circuits.

The graph showing the relationship between different current and voltages of transistor are known as the characteristics of the transistor. The characteristics of a transistor are of two types -
(i) input characteristics (ii) Output characteristics

Input characteristics-
The graph showing the variation of base current (I_B) with the emitter-base voltage (V_{EB}) at a constant collector-emitter voltage (V_{CE}) are called input charac.
First the output voltage V_{CE} is kept at zero and the input voltage V_{BE} is gradually increased and the input current I_B is noted. Then again the output

Observations :-

(i) Input characteristics :-

I_B (μA)	V_{BE} (V)	
	V_{CE} = 5V	V_{CE} = 10 V
0.0	0.0	0.0
5.0	0.42	0.44
10.0	0.44	0.46
15.0	0.46	0.48
20.0	0.48	0.50
30.0	0.50	0.52

(ii) Output Characteristics :-

V_{CE} (V)	I_C (mA)			
	I_B = 0 μA	I_B = 20 μA	I_B = 40 μA	I_B = 80 μA
0	0.0	0.0	0.0	0.0
0.5	0.0	6.0	10.0	14.5
1.0	0.0	7.0	14.0	16.5
2.0	0.0	9.5	16.0	17.5
4.0	0.0	11.0	18.0	22.5

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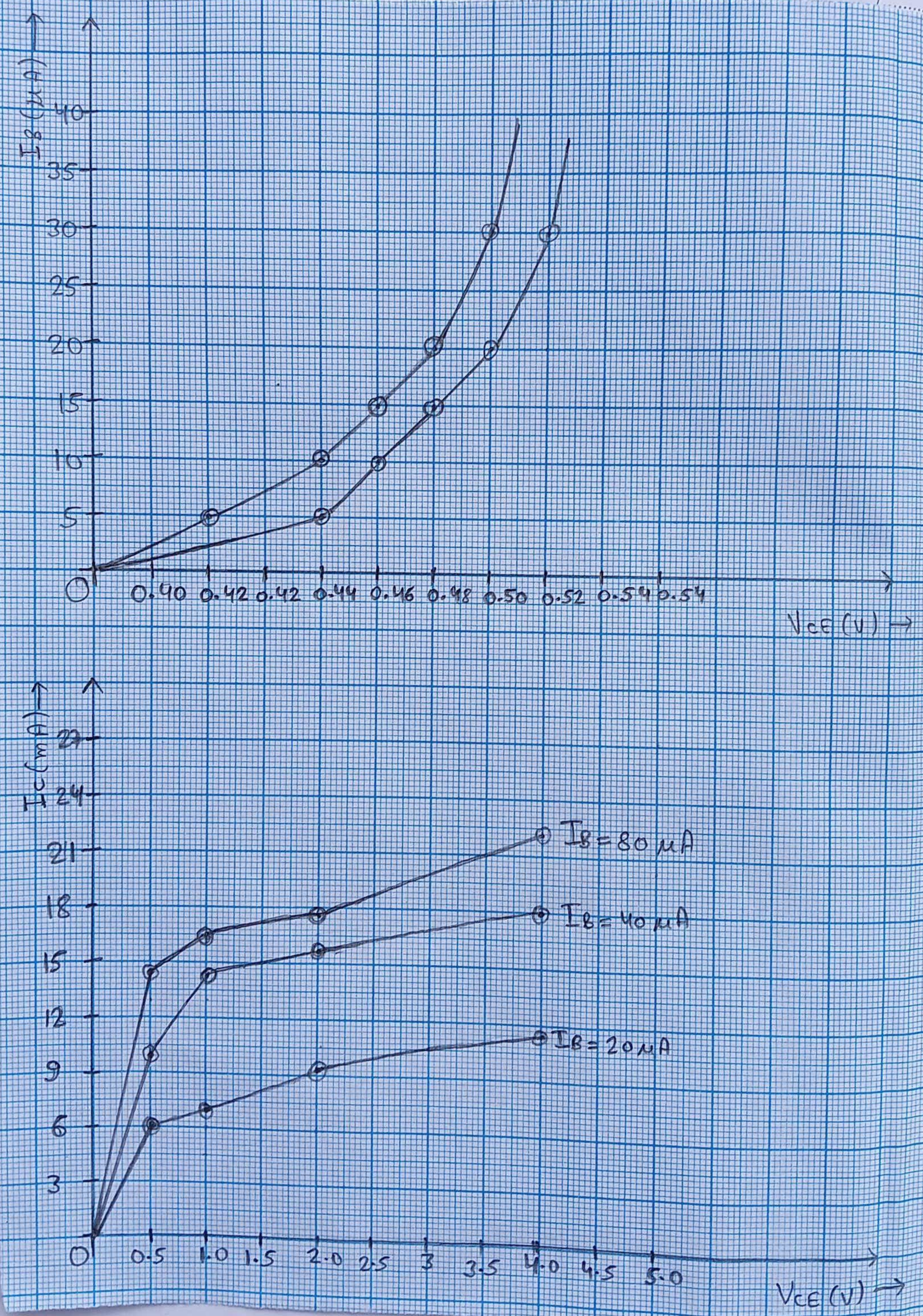


I_B (μA)
40
35
30
25
20
15
10
5
O
0.40 0.42 0.42 0.44 0.46 0.48 0.50 0.52 0.54 0.54
V_{CE} (V)
I_C (mA)
27
24
21
18
15
12
9
6
3
O
0.5 1.0 1.5 2.0 2.5 3 3.5 4.0 4.5 5.0
V_{CE} (V)
I_B = 80 μA
I_B = 40 μA
I_B = 20 μA

voltage V_{CE} is increased like 10V, 20V and kept constant and by increasing the input voltage V_{CE}, the input current I_B is noted. Hence we conclude that when the input voltage V_{BE} is increased initially there is no current produced further when it is increased the input ~~voltage~~ current I_B increased steeply. when the output voltage V_{CE} is further increased the curve shifts right side.

Output characteristics -

Output characteristics is the relationship between the output current and the output voltage keeping input current constant. Here the value of output current I_C and the output voltage V_{CB} is noted keeping input current I_B const.

In active region when the output voltage is increased there is very slight change in the output voltage. The curve looks almost flat in the active region. Cutoff region is the region where the input current is below zero. when both the junctions are forward biased, it is the saturation region lies close to the zero voltage axis where all the curve coincide and fall rapidly towards the origin.

Calculations :-

Input dynamic resistance $= \frac{\Delta V_{BE}}{\Delta I_B} = \frac{(0.44-0.42)\,V}{(10-5)\,\mu A}$

$= 0.004 \times 10^6\ \Omega$

$= 4 \times 10^3\ \Omega$

Output dynamic resistance $= \frac{\Delta V_{CE}}{\Delta I_C} = \frac{(1.0-0.5)\,V}{(7.0-6.0)\,mA}$

$= 0.5 \times 10^3\ \Omega$

$= 5 \times 10^2\ \Omega$

Signature

Procedure :-

A- Input characteristics-

1) Make the circuit connections as shown in the circuit diagram.
2) Set the voltage $V_{CE} =$ V and vary I_B with the help of V_{BB} and measure V_{BE} and take 4-5 readings.
3) Set the Voltage $V_{CE} =$ V and vary I_B and measure V_{BE} and again take 4-5 readings.
4) Plot graph of. I_B vs V_{BE}
5) Evaluate dynamic input resistance which is the ratio of change in V_{BE} to the resulting change in the base current at constant collector-emitter voltage. It is given by $\Delta V_{BE} / \Delta I_B$
6) The reciprocal of the slope of the linear part of the characteristics gives the dynamic input resistance of the transistor.

B- Output characteristics-

1) Make the circuit as shown in diagram.
2) Keep I_B constant at μA, vary V_{CE} and note down the collector current I_C.
3) Now Keep $I_B =$ μA and vary V_{CE} and note down the collector current. I_C.
4) Now, again repeat above steps at $I_B =$ μA. and $I_B =$ μA

5). Plot graph of. I_B v/s V_{CE}.
6). The change in collector emitter voltage causes small change in the collector current for the constant base current, which defines the dynamic output resistance and is given as $\Delta V_{CE} / \Delta I_C$ at constant I_B.
7) ~~the~~ finally calculate output resistance from the linear part of the graph.

Result :-

Input dynamic resistance = $4 \times 10^3 \ \Omega$

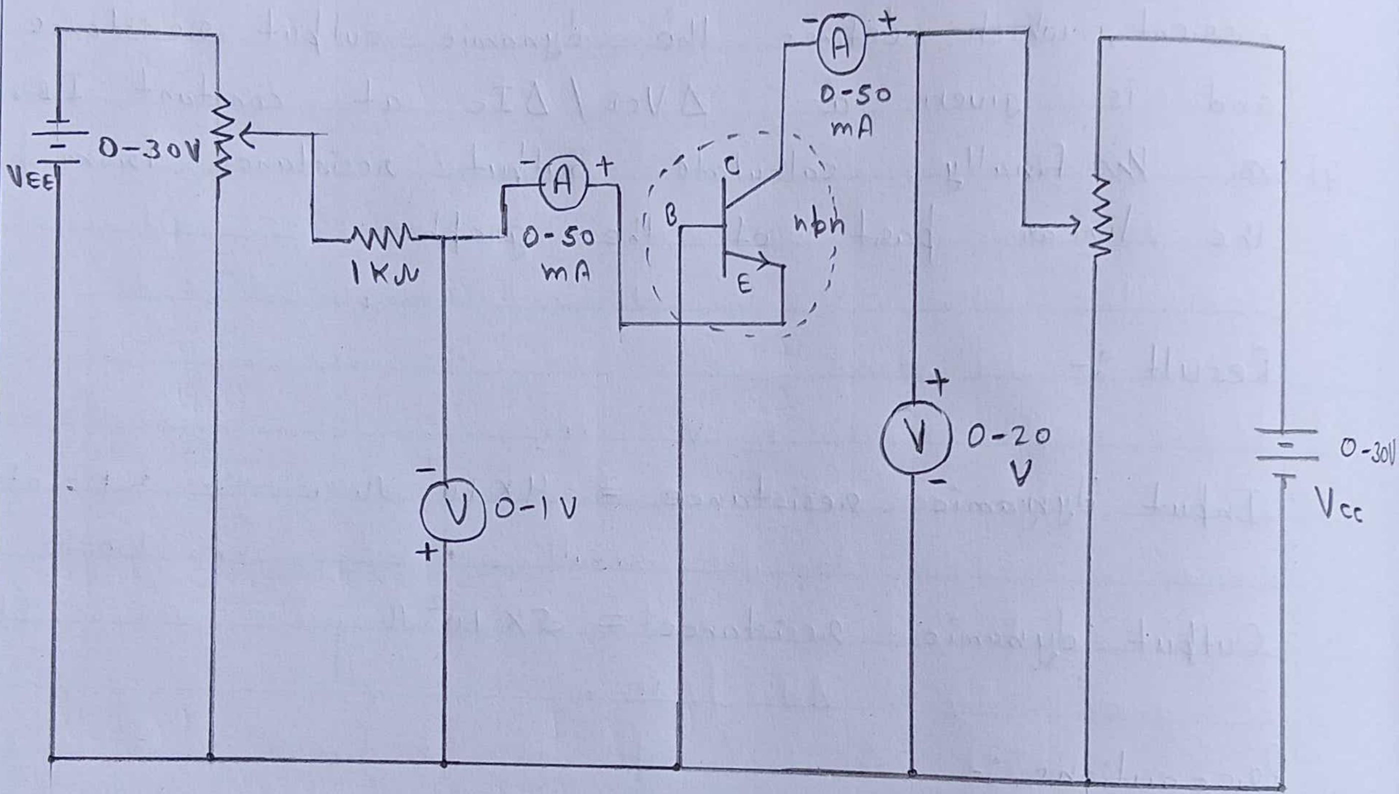
Output dynamic resistance = $5 \times 10^2 \ \Omega$

Precautions :-

1) The connections should be neat, clean and tight.
2) Key should be used when the circuit is being used.
3) Beyond breakdown, forward bias voltage should not be applied.
4) Beyond breakdown, reverse bias voltage should not be applied.
5) Take readings accurately and do calculations carefully.

Exp - 7

Circuit Diagram :-



Experiment - 7

Aim :- To study and plot input and output characteristics of common-base transistor and calculate input and output resistance.

Apparatus :- Transistor, resistor ($1 K\Omega$), voltmeter (0-1V, 0-20V), ammeter (0-50 mA, 0-50 mA), two power supplies, bread board, connecting wires.

Theory :- In common-base transistor, base of the transistor is common between the input and output.

(i) Input characteristics-
Keeping V_{CB} constant, we study changes in V_{BE} due to change in I_E.

(ii) Output characteristics-
Keeping I_E constant, we study changes in I_C due to changes in V_{CB}.

Procedure :-

To obtain input characteristics -

1) Connect circuit as shown in the circuit diagram for input characteristics.

Observations :-

Input characteristics -

I_E (mA)	V_{BE} (V)	
	$V_{CB} = 0V$	$V_{CB} = 0.5V$
0.0	0.00	0.00
0.5	0.66	0.68
1.0	0.70	0.72
2.0	0.72	0.74
3.0	0.76	0.77
4.5	0.78	0.82

Output characteristics -

V_{CB} (V)	I_C (mA)			
	$I_E = 0$ mA	$I_E = 1$ mA	$I_E = 2$ mA	$I_E = 3$ mA
0	0	1	2	3
1	0	1	2	3
2	0	1	2	3
3	0	1	2	3
4	0	1	2	3
5	0	1.1	2.1	3.1

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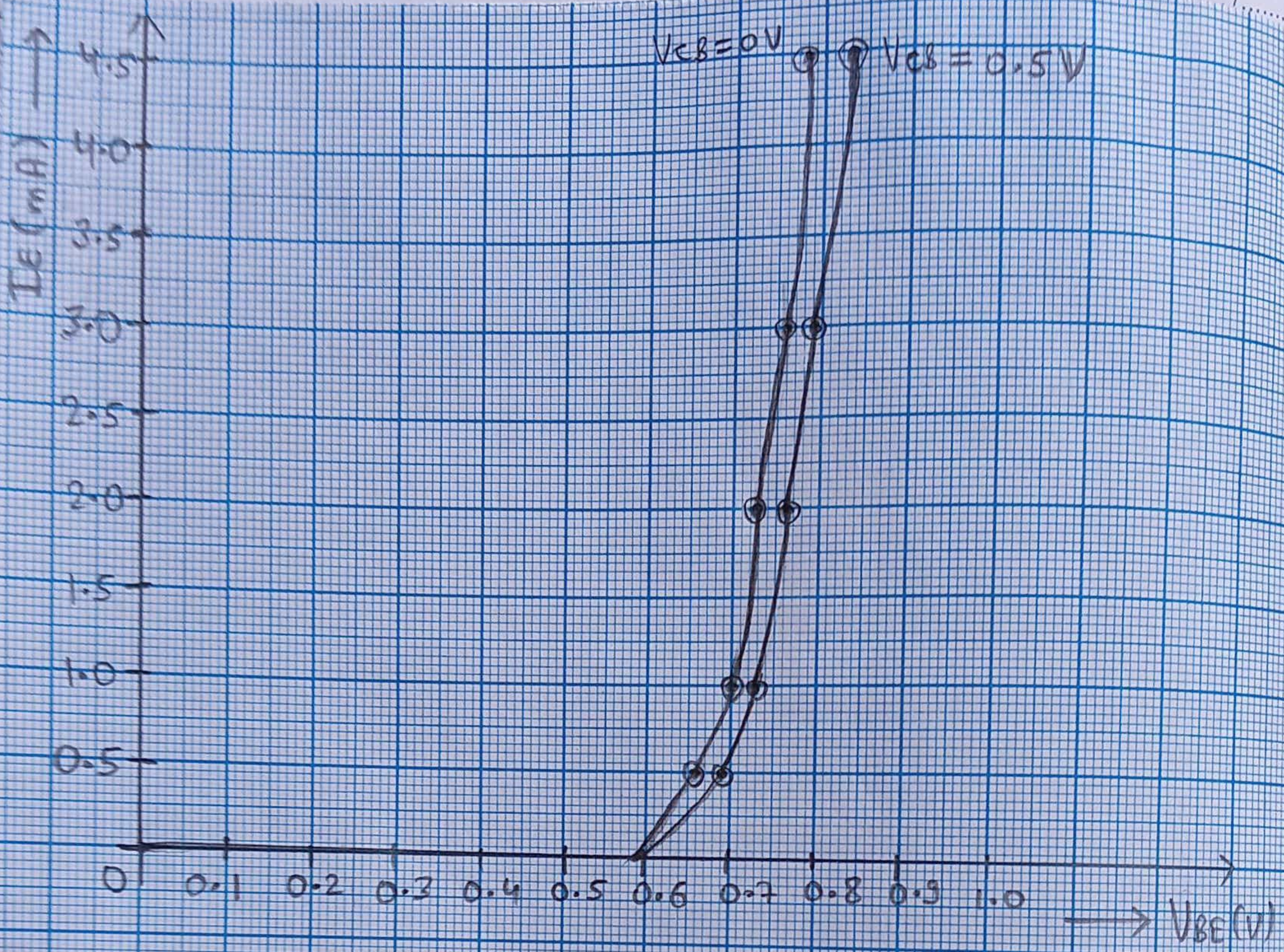
IE (m

0.0
0.5
1.0
2.0
3.0
4.5



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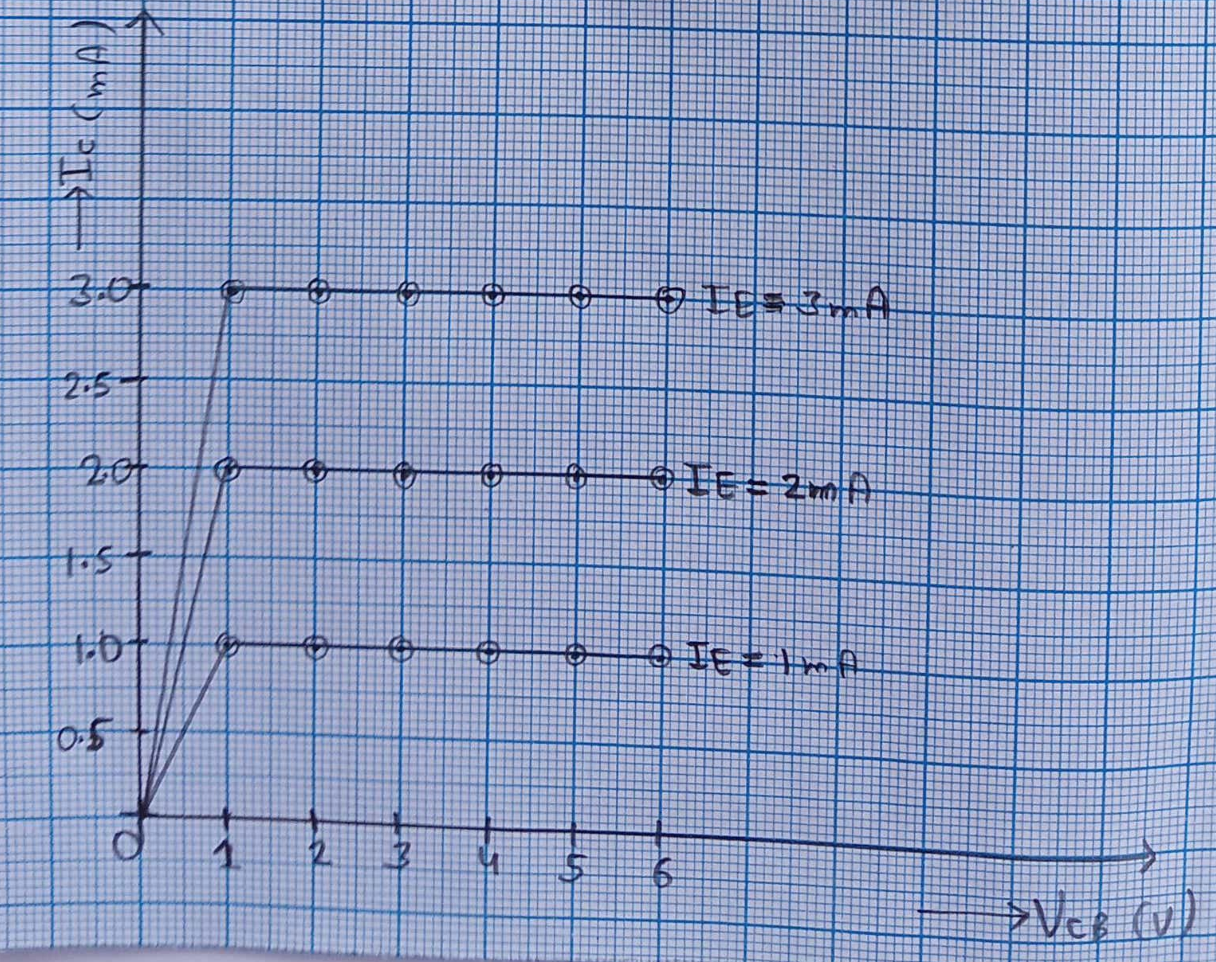
B (V)

0
1
2
3
4
5



2) connect variable power supply (VEE) at emitter base circuit and another power supply V_{CE} at collector base circuit.
3) Keep output voltage $V_{CB} = 0\,V$ by varying V_{CC}
4) Varying V_{CE} gradually and notedown the emitter current (I_E) and emitter base voltage. (V_{CE})
5) Repeat above steps at. $V_{CB} = 0.5\,V$ and get diff. readings at $I_E = 0, 0.5, 1.0, 2.0$, etc
6) Plot the graph and find ~~out~~, resistance

Output characteristics -
1) Keep $I_E = 0\,mA$ by adjusting V_{EE} and note down I_C value at diff - diff. V_{CB} value.
2). Repeat the above steps and at. $I_E = 1mA, 2mA, 3mA$ and note down readings.
3). Plot the graph.
4) Calculate the resistance.

Result :-

Input resistance (dynamic) = $80\,\Omega$

Output dynamic resistance = $20\,K\Omega$

Calculations :-

Input resistance $= \dfrac{\Delta V_{BE}}{\Delta I_E}$

$$= \frac{(0.70 - 0.66)\,V}{(1.0 - 0.5)\,mA}$$

$$= 0.08 \times 10^3\ \Omega$$

$$= 80\ \Omega$$

output resistance $= \dfrac{\Delta V_{CB}}{\Delta I_C}$

$$= \frac{(6-4)\,V}{(1.1-1)\,mA}$$

$$= \frac{2}{0.1 \times 10^{-3}}\ \Omega$$

$$= 20\ K\Omega$$

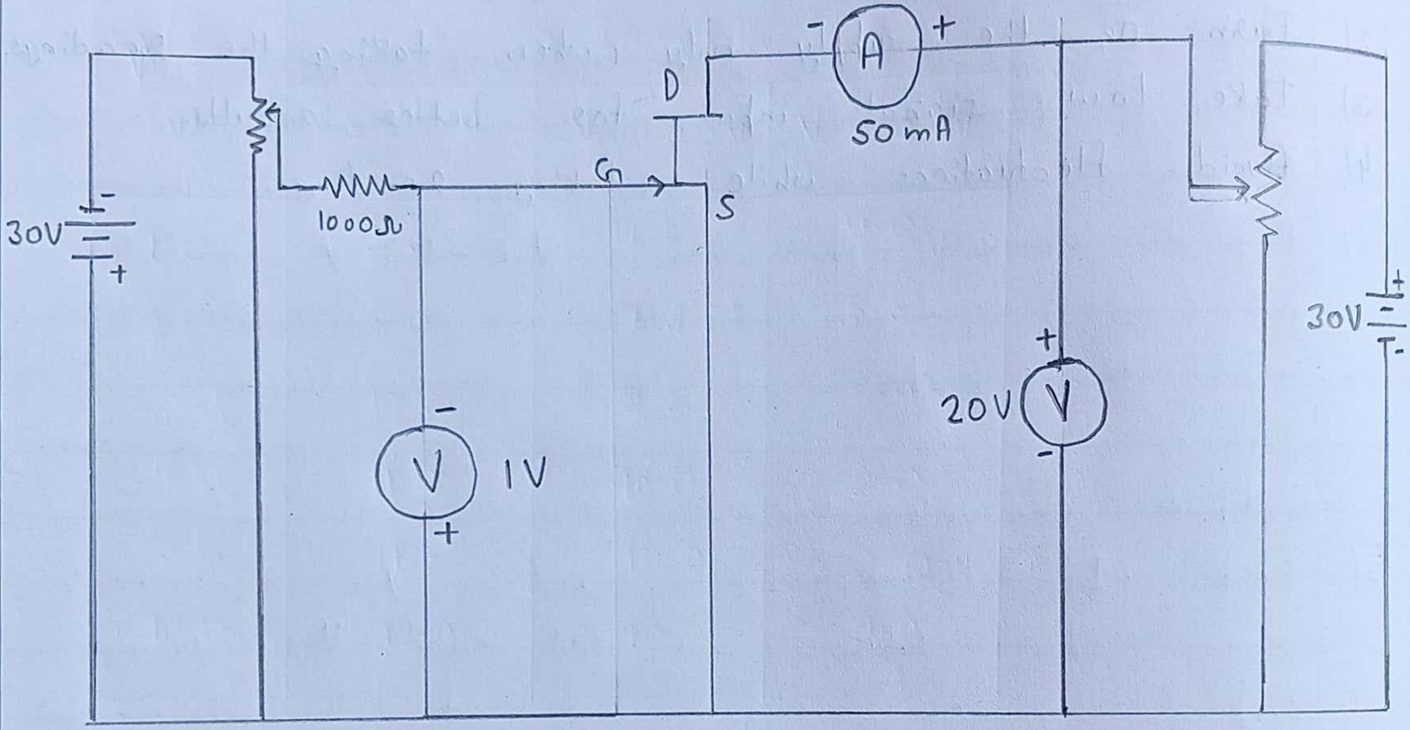
Signature

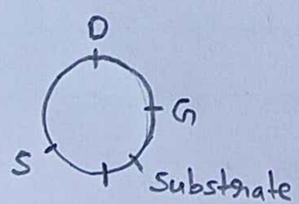
Precautions :-

1) The connections should be neat, clean and tight.
2). Turn on the supply only when taking the readings.
3). Take low signal input for better results.
4) Avoid fluctuations while taking readings.

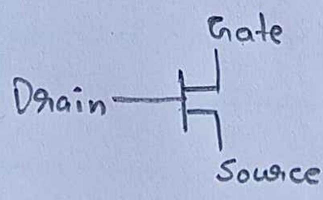
Experiment - 8

Circuit Diagram :-





FET



FET

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Experiment - 8

Aim :- To study and plot the characteristics of FET (Field Effect Transistor) and calculate dynamic dynamic resistance (r_d), mutual conductance (g_m), amplification factor (μ) and pinch off voltage (V_P).

Apparatus :- FET, voltmeter (0-1V, 0-20 V), ammeter (0-50 mA), two power supplies, bread board, connecting wires

Theory :- The FET like bipolar junction transistor is a three terminal semiconductor device. It is called unipolar device because current flow is only due to one type of charge, carriers i.e holes or e⁻. The current flow is controlled by an electric field set up in the device by an externally applied voltage.

Its characteristics are obtained between the drain to source voltage (V_{DS}) and drain current (I_D) by taking gate to source voltage (V_{GS}) as the constant parameter.

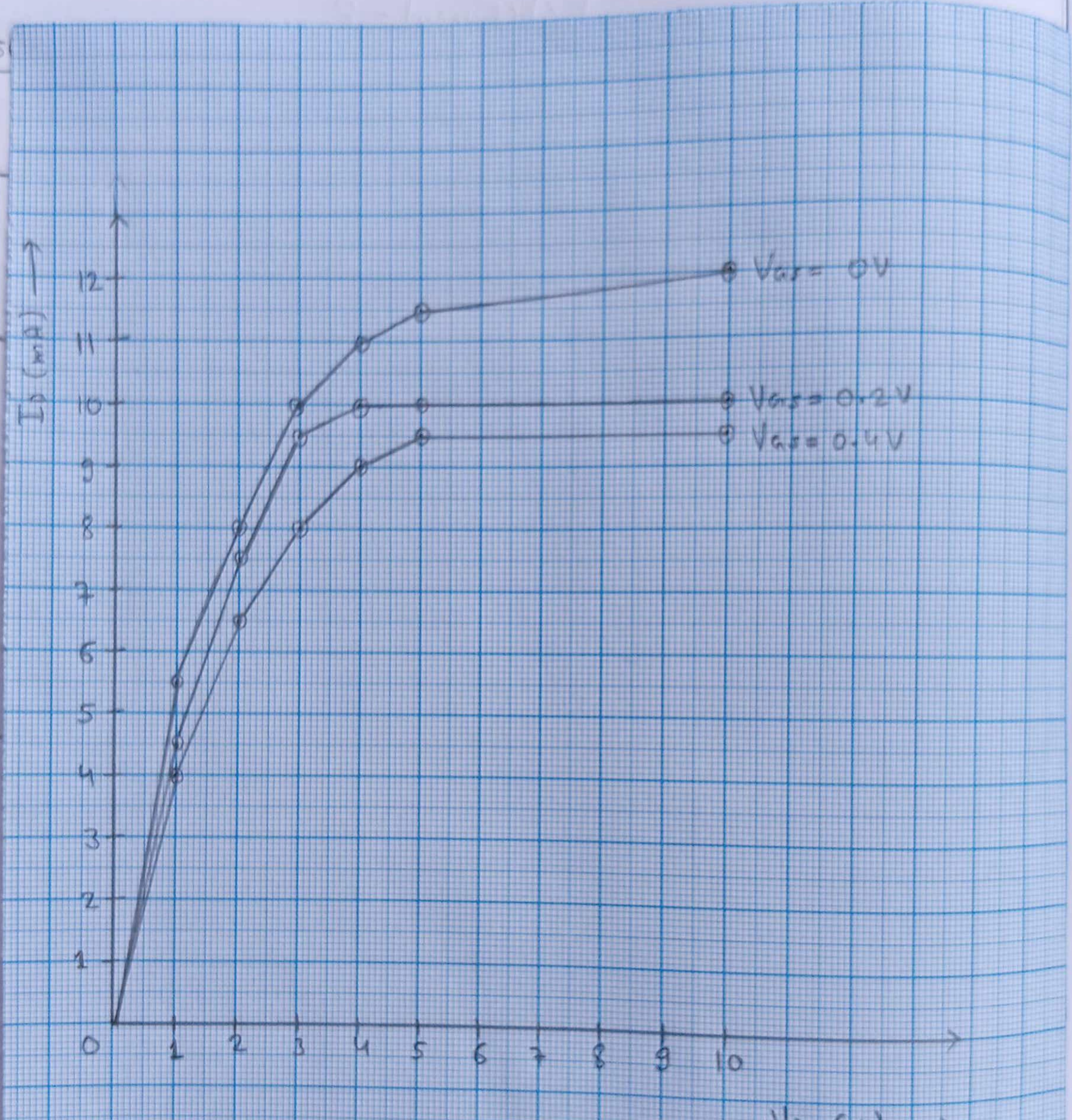
1) Dynamic resistance - It is the ratio of change in V_{DS} to change in I_D at constant V_{GS}.

$$r_d = \frac{\Delta V_{DS}}{\Delta I_D} \quad \text{at constant } V_{GS}$$

Observation Table :-

V_{DS} (V)	I_D (mA)		
	$V_{GS} = 0$ V	$V_{GS} = 0.2$ V	$V_{GS} = 0.4$ V
1.0	5.5	4.5	4.0
2.0	8.0	7.5	6.5
3.0	10.0	9.5	8.0
4.0	11.0	10.0	9.0
5.0	11.5	10.0	9.0
10.0	12.0	10.0	9.0

Obs


I_D (mA)
12
11
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
V_{GS} = 0V
V_{GS} = 0.2V
V_{GS} = 0.4V
V_{DS} (V)

Dated ....../....../......

2) Amplification factor (μ) :- It is ratio of change in V_{DS} to change in V_{GS} for current I_D.

$$\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}} \quad \text{at constant } I_D$$

$$\mu = (r_d \times g_m)$$

3) Pinch off Voltage – It is the drain to source voltage after which the drain to source current becomes almost constant and JFET enters into saturation region. and is defined only when gate source (V_{GS}) voltage is zero.

4) Mutual conductance (g_m) – It is the ratio of change in I_D to change in V_{GS} at constant V_{DS}

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} \quad \text{at constant } V_{DS}$$

Procedure :-

1) Connect the circuit as shown in the figure.
2) First keep $V_{GS} = 0\,V$ by varying V_{GG}
3) Now, start varrying V_{DS} gradually in steps of 1V and note the readings of corresponding drain

Calculations :-

$$r_d = \frac{\Delta V_{DS}}{\Delta I_D} = \frac{(3-2)\,V}{(10-8)\,mA} = \frac{1}{2} \times 10^3\,\Omega = 5 \times 10^2\,\Omega$$

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} = \frac{(7.5-6.5)\,mA}{(0.4-0.2)\,V} = 5 \times 10^{-3}\,S$$

$$\mu = r_d \times g_m = 5 \times 10^2 \times (5 \times 10^{-3})$$
$$= 25 \times 10^{-1}$$
$$= 2.5$$

Signature

current I_D.

4) Repeat above steps for $V_{GS} = 0.2\,V$ and $0.4\,V$.
5) Draw the graph
6) Do the calculations using formulae.

Result :-

dynamic resistance (r_d) = $5 \times 10^{2}\,\Omega$

mutual conductance (g_m) = 5×10^{-3} ~~A~~ S

amplification factor (μ) = 2.5

Precautions :-

1) while performing the experiment, do not exceed the ratings of FET.. This may damage FET.
2) Properly identify source, drain, and gate terminal of FET before connecting it in bread board.
3) Turn on the supply only when taking the readings.