

20CSE103

**Aim:** To draw the IV characteristics of zener diode and to determine the knee voltage, zener voltage and dynamic resistance in breakdown region.

**Apparatus:** Zener diode

DC power supply (0 to 20V)  
Digital voltmeter  
Digital ammeter  
Resistor circuit unit.

**Theory:**

A Diode is a semiconductor device which permits current only in one direction. A diode is formed when two doped p-type and n-type semiconductor are joined making a p-n junction. The intrinsic nature of n-type semiconductor makes it to lose electrons to the p-type semiconductor whose intrinsic nature makes it to fill up the holes. There is exposed charges left at the dopant atom sites near the junction through which a voltage is developed from the electric field at the junction.

**Forward biasing** is a biasing wherein a external voltage applied across the diode that permit current to flow easily. In forward biasing p-side of the diode is attached to positive terminal and n-side is fixed to the negative side of the battery.

**Diode Equation -**

$$I_D = I_s \left( e^{\frac{qV_D}{nKT}} - 1 \right)$$

$I_D \Rightarrow$  Diode Current  $V_D$  diode Voltage.

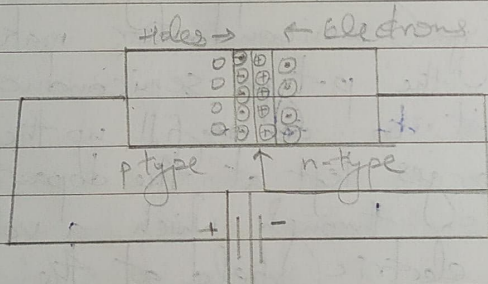


20CSE1030

A zener diode is a special, heavily doped p-n junction semiconductor device that permits current to flow in either forward or reverse direction. ~~then~~ Zener diode is different from normal diode in a way that it is highly doped and thus there will be constant reverse saturation current due to minority carriers.

### Procedure:

Forward bias: In forward biasing positive terminal is connected to p type and negative terminal is connected to n type side. When the p-n junction is forward biased the majority carrier of p-n region will be moving toward the junction & depletion layer is reduced.

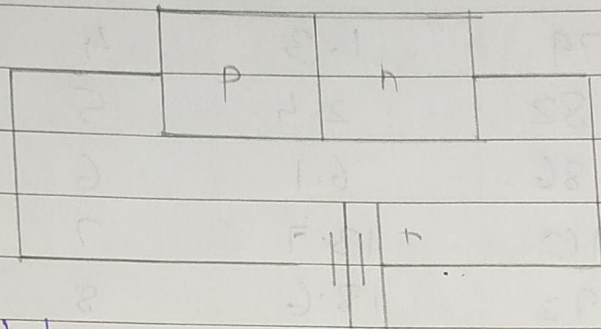


Forward bias.

knee voltage: the voltage in forward biasing at which flow of current through the PN junction of the diode increases rapidly is called knee voltage.

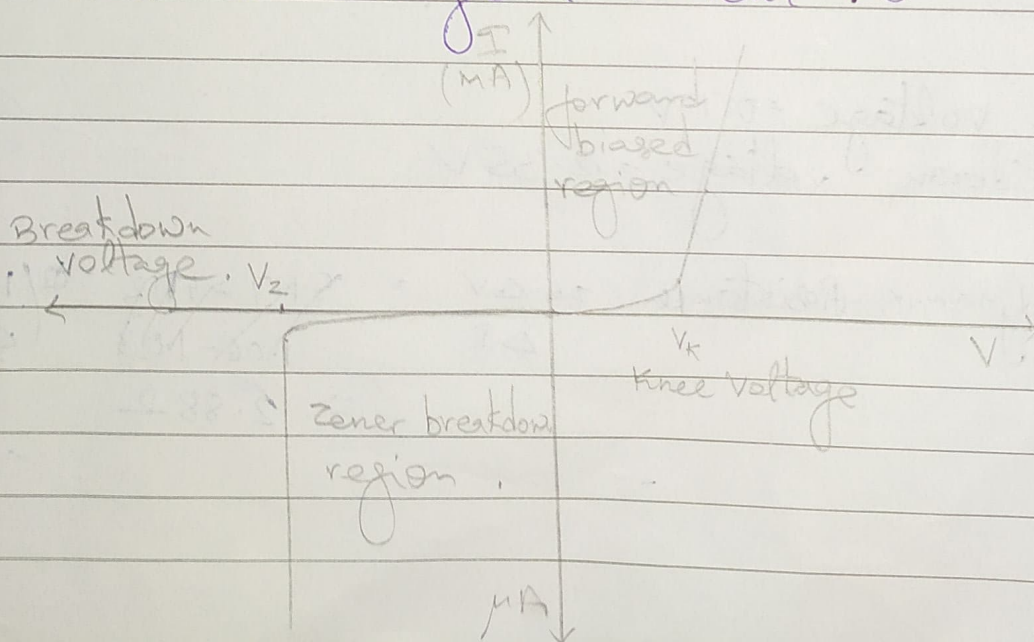
Reverse Bias: Reverse biasing is a condition when p-side of diode is connected to negative terminal of battery and n-side is connected to the positive terminal of battery. This causes an increase in the thickness of the depletion layer.





**Zener breakdown voltage:** When reverse biased voltage is applied to the Zener diode reaches Zener voltage, it starts allowing large amount of electric current. At this point, slight increase in reverse voltage will rapidly increase the electric current. Because of this sudden rise in electric current breakdown occurs called Zener breakdown.

**Dynamic Resistance:** Ratio of the change in voltage ~~div~~ to change in current.



20CSE1030

SNo.	Fb (V)	F.b $I(mA)$	Rb (V)	R.b ( $I$ )
1	0	0	0	0
2	0.07	0	0.5	0
3	0.15	0	1	0
4	0.55	0	1.5	0
5	0.72	0.1	2	0
6	0.77	0.5	3	0
7	0.79	1.3	4	0
8	0.82	2.4	5	0
9	0.86	6.1	6	0
10	0.90	13.7	7	0
11	0.92	18.6	8	0
12	0.95	23.2	9	0
13	0.99	31.5	10	0
14	1.01	36.9	11	0
15	1.03	41.3	12	0
16	1.04	47.2	12.25	0.07
17	1.06	51.7	12.35	1.8
18	1.08	56.5	12.55	5.2
19	1.10	62.4	12.70	9.8
20	1.12	68.5	13.58	12.7

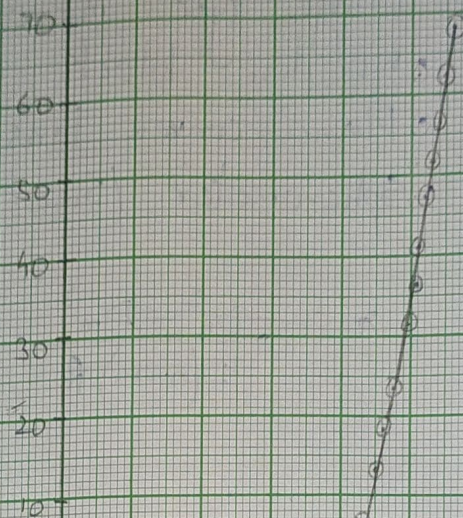
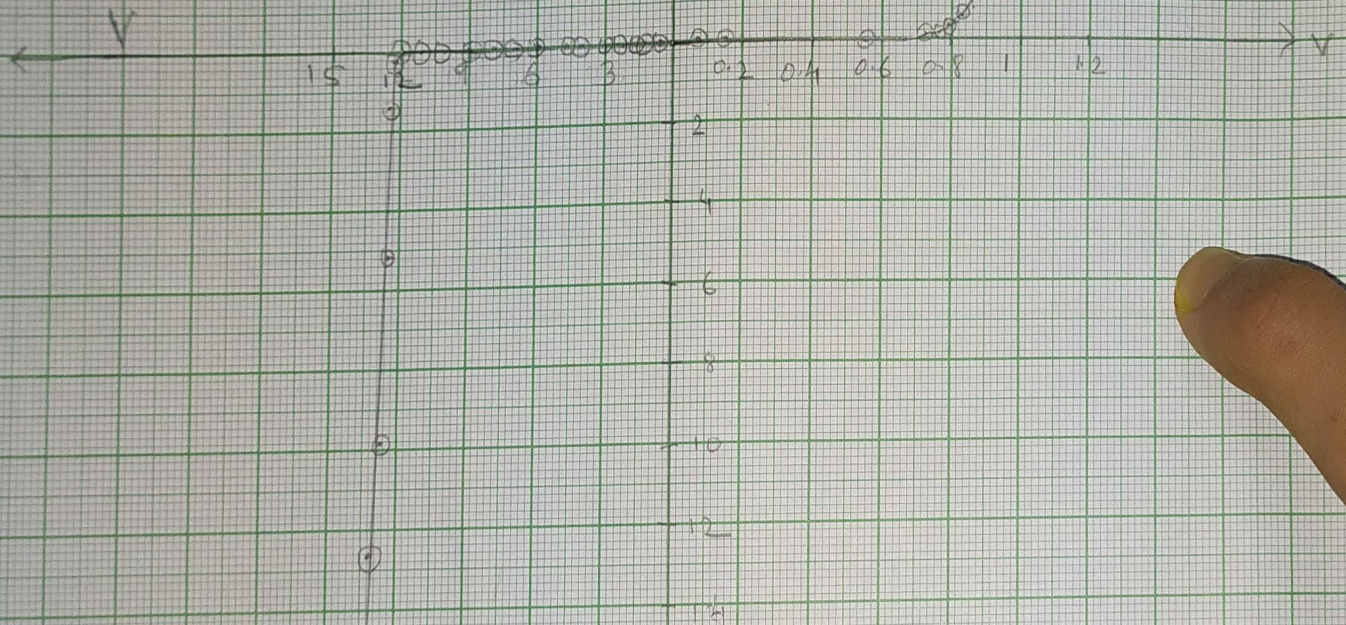


I  
(mA)

Scale

x axis: 1 unit = 0.2

y axis: 1 unit = 10

Slope  $\frac{51.7 - 41.3}{1.06 - 1.03}$  $= 0.3467$  $R_2 = \frac{1}{\text{slope}} = 2.88 \Omega$ 

Scale: x axis: 1 unit = 3

y axis: 1 unit = 2

I  
(mA)



$$\text{Knee voltage} = 0.77\text{V}$$

$$\text{Breakdown voltage} = 12.35\text{V}$$

$$\text{Dynamic resistance} = \frac{\Delta V}{\Delta I} = \frac{1.06 - 1.03}{51.7 - 41.3} \times 10^3$$
$$= 2.88\Omega$$

from graph

$$\text{Knee voltage} = 0.77\text{V}$$

$$\text{Breakdown voltage} = 12.35\text{V}$$

$$\text{Dynamic Resistance} = 2.88\Omega$$

$$\text{Avg. DR} = \frac{2.88 + 2.88}{2}$$

$$\text{DR} = 2.88\Omega$$

~~Result~~

Conclusion:

As the voltage starts rising over the knee voltage value in forward biasing, the current starts rising and be proportional to voltage.

As the voltage exceeds the breakdown voltage in reversed biased condition the current shoots up.

Result:

The knee voltage of diode is  $0.77\text{V}$

The breakdown voltage of diode is  $12.35\text{V}$

Dynamic Resistance of diode is  $2.88\Omega$

## Applications:

- Zener diodes are used as voltage regulators. Also used in clipper circuits.
- Also diodes are used in clamper, rectifier, logic gates, etc.