Expt. No.5. Diode characteristics

Aim:

1. Calculate the forward and reverse characteristics of a ordinary and zener diode
2. Compare the results.

Apparatus:

Zener diode, voltmeter, micro ammeter and connecting wires, Power supply etc.

Theory:

A diode is a semiconductor device in which, a p-type semiconductor is suitably joined to n-type semiconductor, and the resulting contact surface is called P-N junction diode.

The voltage across P-N junction diode can be measured in two ways.

1. Forward biasing.
2. Reverse biasing.

1. Forward biasing: If the positive terminal of the battery is connected to the p-side of the diode and negative terminal to the n-side, then the diode is said to be forward biased. During the forward bias the flow of the current is due to majority charge carriers and the current is of the order of mill amperes.

2. Reverse biasing:. If the positive terminal of the battery is connected to the n-side of the diode and negative terminal to the p-side, then the diode is said to be reverse biased. During the reverse bias the flow of the current is due to minority charge carriers and the current is of the order of microamperes.

Zener diode: A p-n junction diode, which is heavily doped in order to sustain heavy current at breakdown region, is known as Zener diode.

A Zener diode is also called a voltage regulator or breakdown diode. Breakdown can be made to occur abruptly and accurately to known values ranging from 2.4V to 200V with different power ratings. The breakdown voltage V_z depends on the amount of doping.

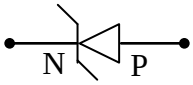
Reverse breakdown: there is a limit to how much reverse voltage a diode can withstand before it is destroyed. There are two mechanisms which give rise to breakdown of p-n junction under reverse condition**.**

1. **Avalanche breakdown:** when the reverse voltage increases it forces the minority charge carriers to move quickly, when this minority charge carriers gain enough kinetic energy, they collide with semiconductor atoms in a depletion region and generate electron-hole pairs. These newly generated carriers in turn gain energy due to electric field and produce ionizing collisions. This process of division may continue until an avalanche of electrons is formed. Thus the minority charge carriers get multiplied and the reverse current increases enormously. This process is known as avalanche effect.
2. **Zener breakdown:** When the diode is heavily doped, the depletion region becomes very narrow and there by the electric field in the depletion region increases. When the reverse bias is increased, the electric field at the junction becomes large enough to

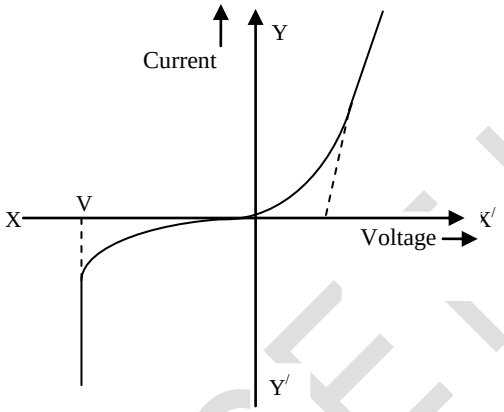
break the covalent bonds and generate electron-hole pairs. Consequently the reverse current rises abruptly at a particular voltage known as Zener breakdown voltage. This effect is called as Zener effect.

This breakdown can be accurately obtained at known values ranging from 2.4V to 200V. This breakdown depends on the amount of doping. Hence Zener diode is reverse biased, heavily doped p-n junction diode.

The circuit symbol for Zener diode is



V-I Characteristics of Zener diode:



The forward characteristic of Zener diode is similar to that of an ordinary forward biased junction diode. When the diode is reverse biased, a small reverse current flows and remains practically constant, until Zener voltage V_z is reached. As soon as the applied voltage equals the Zener voltage of diode the reverse current abruptly increases to a very high value.

From the reverse characteristic of the Zener diode it is clear that as the reverse voltage is increased, the reverse current remains negligibly small up to the knee of the curve and then rapidly increases at V_z. This ability of a diode is called regulation power of the Zener diode.

Zener diode specifications:

The Zener diodes are generally specified in terms of Zener voltage V_z , maximum power dissipation, breakdown current I_z and Zener resistance r_z . The Zener resistance is defined as the ratio of change in Zener reverse voltage to corresponding change in Zener current under reverse bias condition,

i.e, Zener resistance $r_z = V_z / I_z$

Zener diode as voltage regulator:

A Zener diode can be used as a voltage regulator because it maintains the constant output voltage even though the current through it changes. It is usually used at the output of an unregulated power supply to provide constant output voltage.

Some important points about Zener Diode:

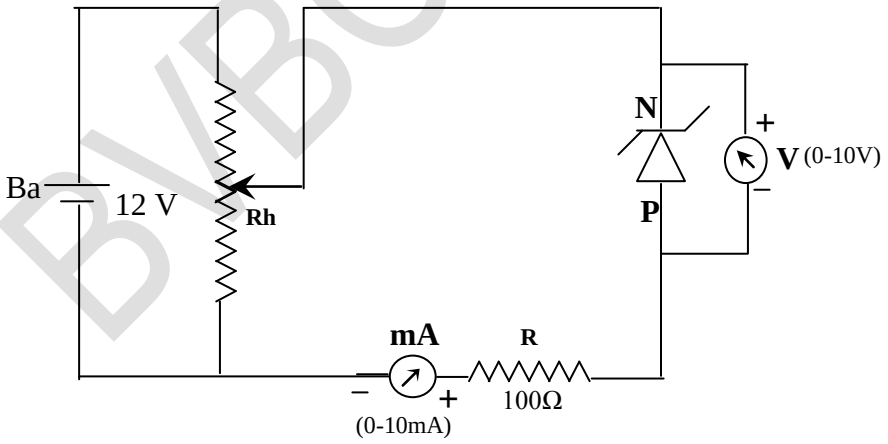
1. Zener diode is like an ordinary diode except that it is properly doped so as to have a sharp breakdown.
2. A Zener diode is always reverse connected.
3. It has a sharp breakdown voltage, called Zener voltage.
4. When forward biased, its characteristics are just that of ordinary diode
5. The Zener diode is not immediately burnt just because it has entered the breakdown region.

Since p and n-type materials are highly doped in Zener diode, the depletion region becomes a very thin layer under a reverse bias of few volts and the field across the junction also becomes very high. Under such conditions of narrow depletion layer, and high field across the junction, the electron can tunnel directly from the valence band on the p-side to the conduction band on the n-side without changing energy

Procedure:

1. Make the connections as shown in fig.
2. Bring the voltage V to zero value. Note the reverse current.
3. Increase the reverse voltage in steps and note the corresponding current. Continue till the breakdown occurs. Note the breakdown voltage Vz.
4. Draw a curve reverse voltage versus reverse current.
5. Find out the Zener breakdown voltage from the graph.

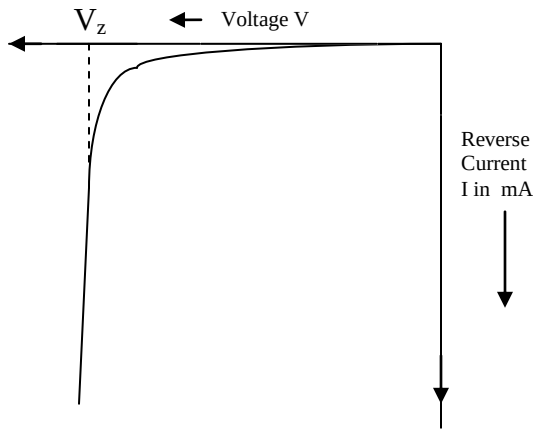
Circuit diagram:



Tabulation:

Sl.No	**Voltage 'Vz' (in volts)**	**Current 'Iz' (in mA)**
Error	±	±
0		
1		
2		
3		

Nature of Graph:



From graph, Breakdown voltage V_Z =……

RESULT:

Zener Breakdown Voltage V_B = ……. volts.

Viva questions:

1) What is Zener diode?
2) What is meant by biasing? What do you mean by forward and reverse biasing?
3) Mention the important difference between ordinary diode and Zener diode?
4) Explain the formation of depletion region in a p-n junction.
5) What is Zener breakdown?
6) What is break down voltage? And what is its significance?
7) What is reverse saturation current?
8) What will be the resistance offered by Zener diode in the breakdown region?
9) If the marking is not done, then how do you identify p and n-side of the diode?
10) Mention the application of Zener diode?