PN JUNCTION DIODE:

PN junction diode is one of the fundamental elements in electronics. In this type of diode, we dope one side of a semiconductor piece with an acceptor impurity and another side with a donor impurity. A PN junction diode is a two-terminal electronics element, which can be classified as either 'step graded' or 'linear graded'

In a step graded PN junction diode, the concentration of dopants both, in the N side and the P side are uniform up to the junction. But in a linearly graded junction, the doping concentration varies almost linearly with the distance from the junction. When we do not apply any voltage across the **PN diode**, free electrons will diffuse through the junction to P side and holes will diffuse through the junction to N side and they combine with each other.

Thus the acceptor atoms in the p-side near the junction edge and donor atoms in n-side near junction edge become negative and positive ions respectively. The existence of negative ions in the p-type side along the junction and positive ions in the n-type side along the junction edge creates an electric field. The electric filed opposes further diffusion of free electrons from the n-type side and holes from the p-type side of the PN junction diode. We call this region across the junction where the uncovered charges (ions) exist, as depletion region.

Biasing of p-n junction semiconductor diode

The process of applying the external voltage to a p-n junction semiconductor diode is called biasing. External voltage to the p-n junction diode is applied in any of the two methods: forward biasing or reverse biasing.

If the p-n junction diode is forward biased, it allows the electric current flow. Under forward biased condition, the p-type semiconductor is connected to the positive terminal of battery whereas; the n-type semiconductor is connected to the negative terminal of battery.

If the p-n junction diode is reverse biased, it blocks the electric current flow. Under reverse biased condition, the p-type semiconductor is connected to the negative terminal of battery whereas; the n-type semiconductor is connected to the positive terminal of battery.

Forward Biased Pn Junction Diode

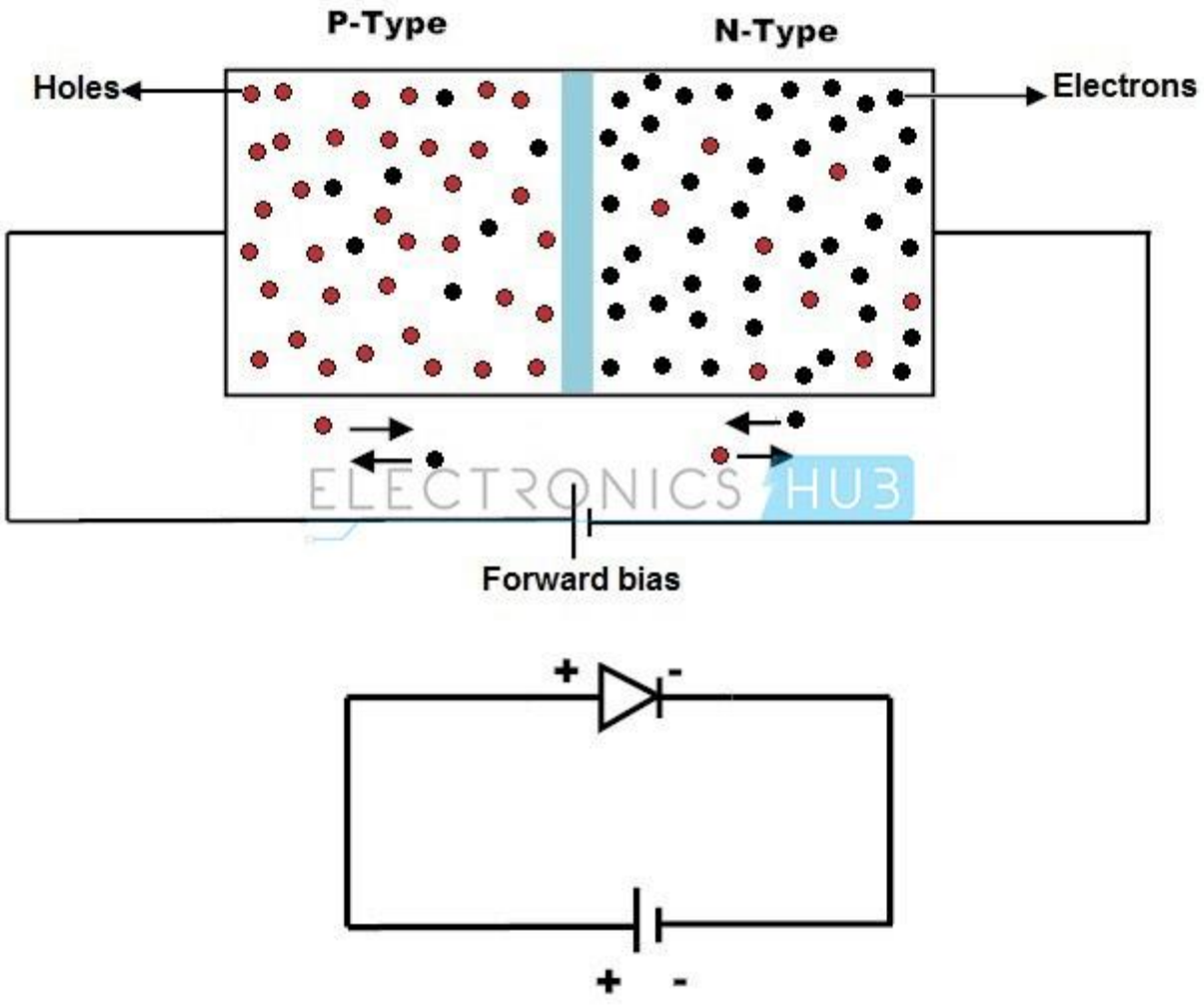
With the externally applied voltage, a potential difference is altered between the P and N regions.When positive terminal of the source is connected to the P side and the negative terminal is connected to N side then the junction diode is said to be connected in forward bias condition. Forward bias lowers the potential across the PN junction.

The majority charge carriers in N and P regions are attracted towards the PN junction and the width of the depletion layer decreases with diffusion of the majority charge carriers. The external

biasing causes a departure from the state of equilibrium and a misalignment of Fermi levels in the P and N regions, and also in the depletion layer.

So an electric field is induced in a direction converse to that of the incorporated field. The presence of two different Fermi levels in the depletion layer represents a state of quasi-equilibrium. The amount of charge Q stored in the diode is proportional to the current I flowing in the diode.

With the increase in forward bias greater than the built in potential, at a particular value the depletion region becomes very much thinner so that a large number of majority charge carriers can cross the PN junction and conducts an electric current. The current flowing up to built in potential is called as ZERO current or KNEE current.



Reverse Biased PN Junction Diode

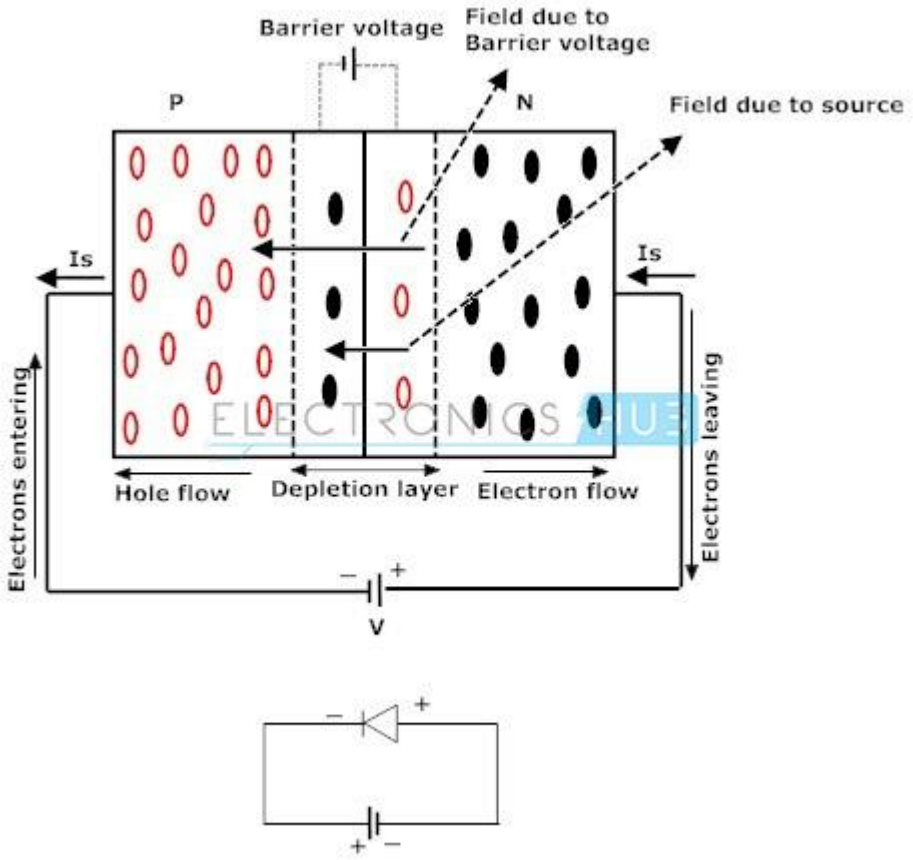
When positive terminal of the source is connected to the N side and the negative terminal is connected to P side, then the junction diode is said to be connected in reverse bias condition. In this type of connection majority charge carriers are attracted away from the depletion layer by their respective battery terminals connected to PN junction.

The Fermi level on N side is lower than the Fermi level on P side. Positive terminal attracts the electrons away from the junction in N side and negative terminal attracts the holes away from the junction in P side. As a result of it, the width of the potential barrier increases that impedes the flow of majority carriers in N side and P side.

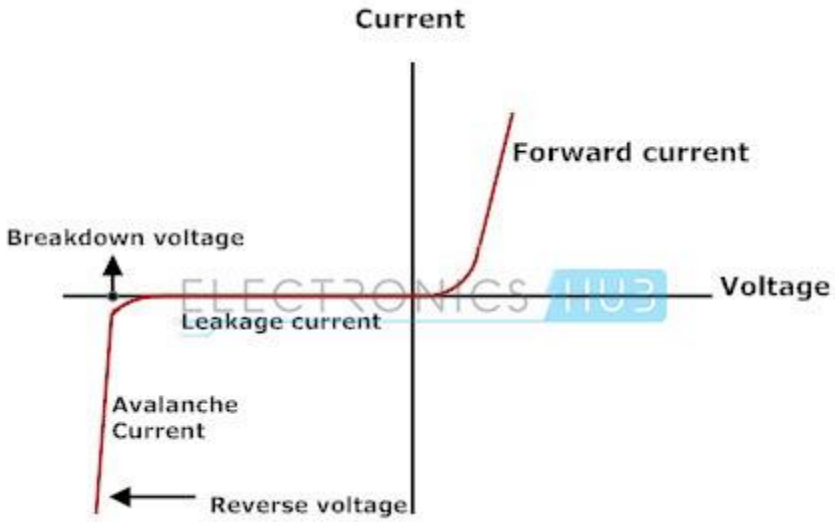
The width of the free space charge layer increases, thereby electric field at the PN junction increases and the PN junction diode acts as a resistor. But the time of diode acting as a resistor is very low. There will be no recombination of majority carriers taken place at the PN junction; thus, no conduction of electric current.

The current that flows in a PN junction diode is the small leakage current, due to minority carriers generated at the depletion layer or minority carriers which drift across the PN junction. Finally, the result is that the growth in the width of the depletion layer presents a high impedance path which acts as an insulator.

In reverse bias condition, no current flows through the PN junction diode with increase in the amount of applied external voltage. However, leakage current due to minority charge carriers flows in the PN junction diode that can be measured in micro amperes.



V-I Characteristics of PN Junction Diode



In the current–voltage characteristics of junction diode, from the first quadrant in the figure current in the forward bias is incredibly low if the input voltage applied to the diode is lower than the threshold voltage (Vr). The threshold voltage is additionally referred to as cut-in voltage.

Once the forward bias input voltage surpasses the cut-in voltage (0.3 V for germanium diode, 0.6-0.7 V for silicon diode), the current spectacularly increases, as a result the diode functions as short-circuit.

The reverse bias characteristic curve of diode is shown in the fourth quadrant of the figure above. The current in the reverse bias is low till breakdown is reached and therefore the diode looks like as open circuit. When the reverse bias input voltage has reached the breakdown voltage, reverse current increases spectacularly.

TRANSISTOR

Introduction to Transistor:

1)Transistor is a semiconductor device that can both conduct and insulate. A transistor can act as a switch and an amplifier.

2)It converts audio waves into electronic waves and resistor, controlling electronic current. Transistors have very long life, smaller in size, can operate on lower voltage supplies for greater safety and required no filament current.

A transistor is a three terminal device. Namely,

- Base: This is responsible for activating the transistor.
- Collector: This is the positive lead.
- Emitter: This is the negative lead.

The basic idea behind a transistor is that it lets you control the flow of current through one channel by varying the intensity of a much smaller current that's flowing through a second channel.

Types of Transistors:

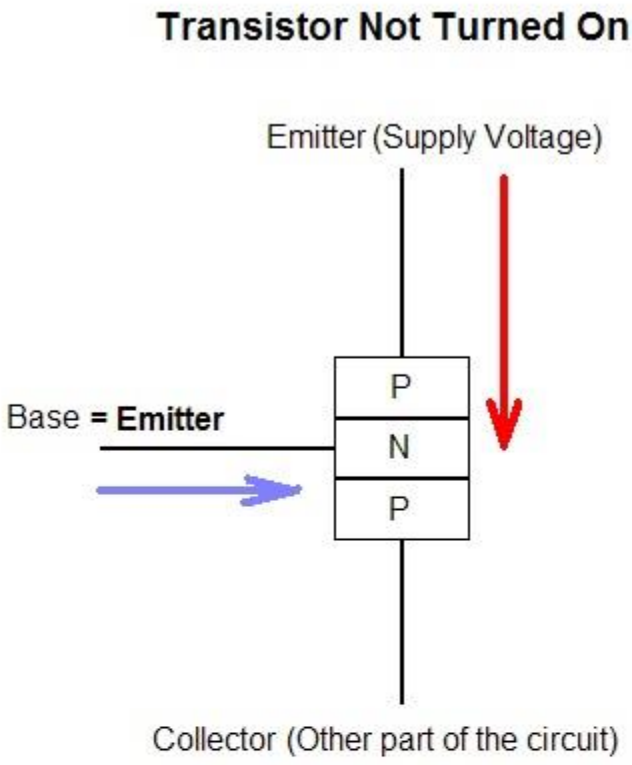
There are two types of transistors in present; they are bipolar junction transistor **(BJT),** field effect transistors **(FET).** A small current is flowing between the base and the emitter; base terminal can control a larger current flow between the collector and the emitter terminals. For a field-effect transistor, it also has the three terminals, they are gate, source, and drain, and a voltage at the gate can control a current between source and drain

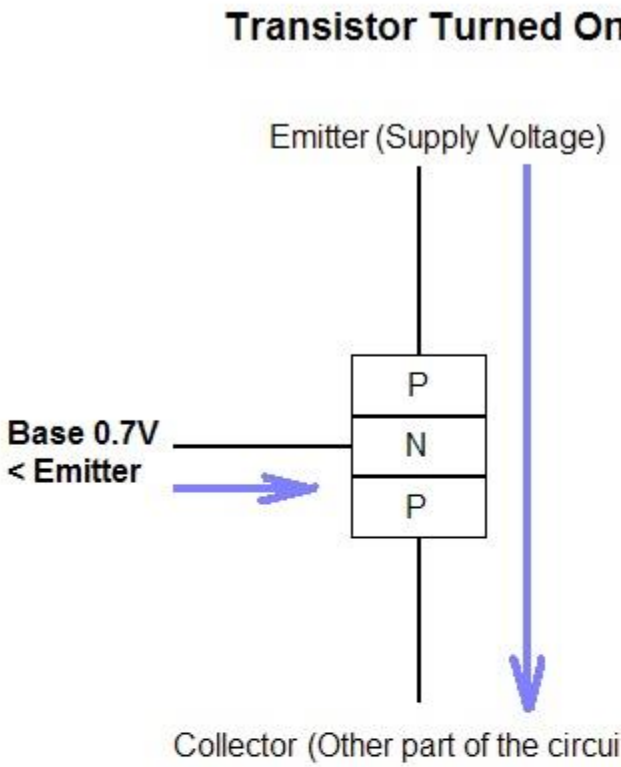
- **Bipolar Junction Transistor:**

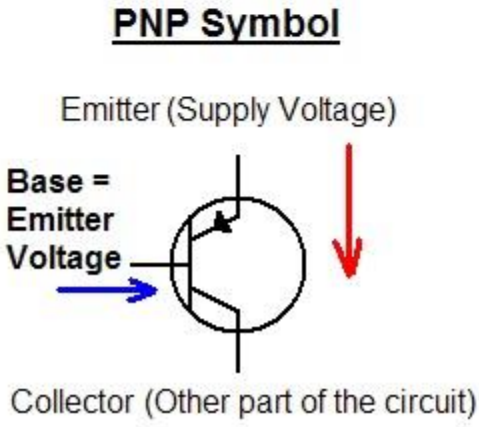
A Bipolar Junction Transistor (BJT) has three terminals connected to three doped semiconductor regions. It comes with two types, **P-N-P and N-P-N.**

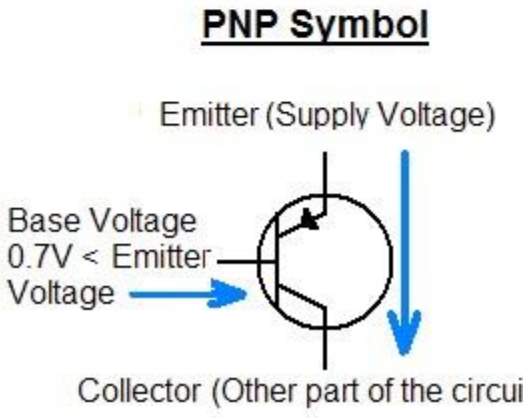
P-N-P transistor, consisting of a layer of N-doped semiconductor between two layers of P-doped material. The base current entering in the collector is amplified at its output.

That is when PNP transistor is ON when its base is pulled low relative to the emitter. The arrows of PNP transistor symbol the direction of current flow when the device is in forward active mode.









N-P-N transistor consisting a layer of P-doped semiconductor between two layers of N-doped material. By amplifying current the base we get the high collector and emitter current.

That is when NPN transistor is ON when its base is pulled low relative to the emitter. When the transistor is in ON state, current flow is in between the collector and emitter of the transistor. Based on minority

carriers in P-type region the electrons moving from emitter to collector. It allows the greater current and faster operation; because of this reason most bipolar transistors used today are NPN.