Unit 1 –

SEMICONDUCTOR DIODES

Class 1

Dr. Shilpa K.C
Assistant Professor
Dept. of Electronics and Communication Engineering
Dr.AIT

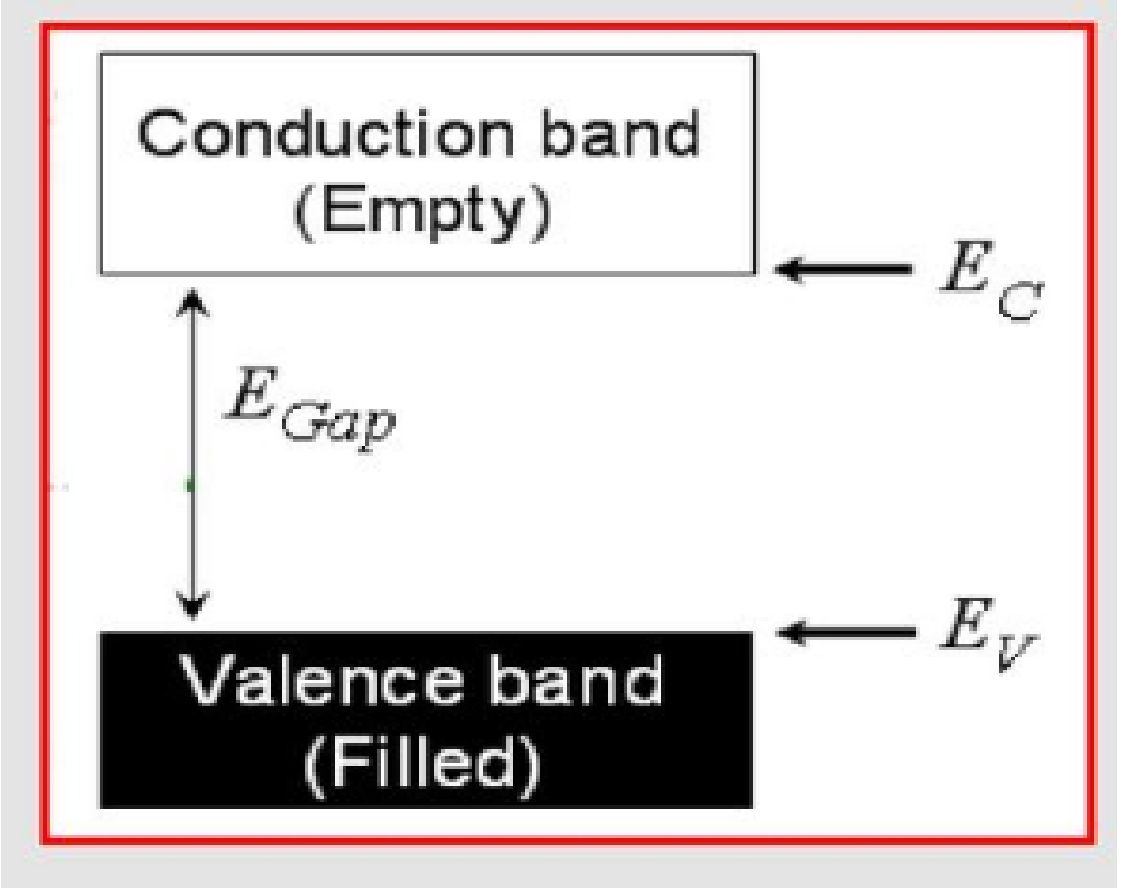
Metals, Semiconductors and Insulators

Insulator

1. In Insulator - the Energy BandGap (Eg) is wider between Conduction Band and Valence Band.
   Diamond -- Eg = 5eV

2. If electric field applied, the electrons in Valence Band (VB) cannot reach Conduction Band.

Energy Diagram of Insulator



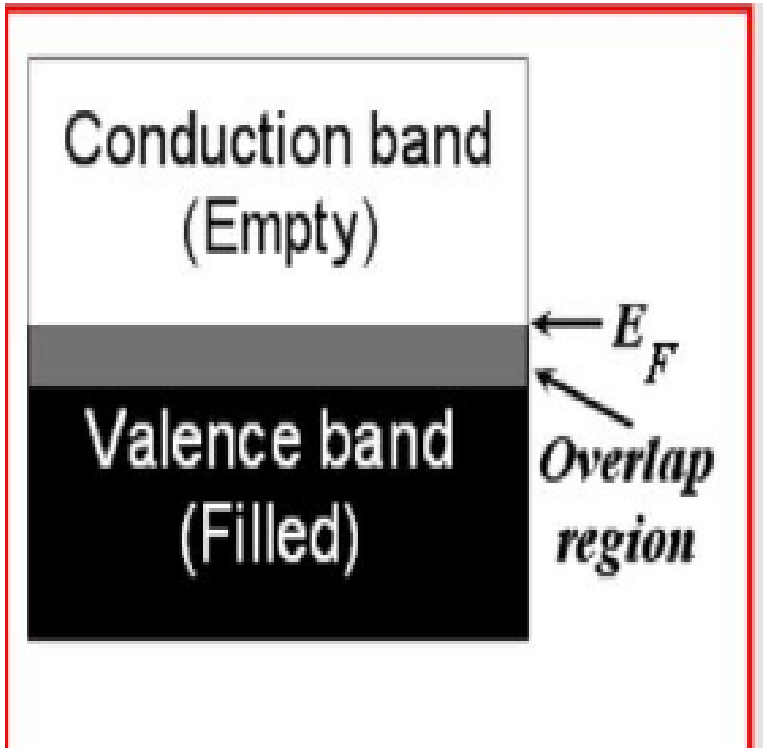
Metals, Semiconductors and Insulators

Metals

1. In Metals, valence band and conduction band overlap each other. Therefore, there is no forbidden gap in a conductor or partially filled conduction band

2. A small amount of applied external energy provides enough energy for the valence band electrons to move in to conduction band.

Energy Diagram of Metals



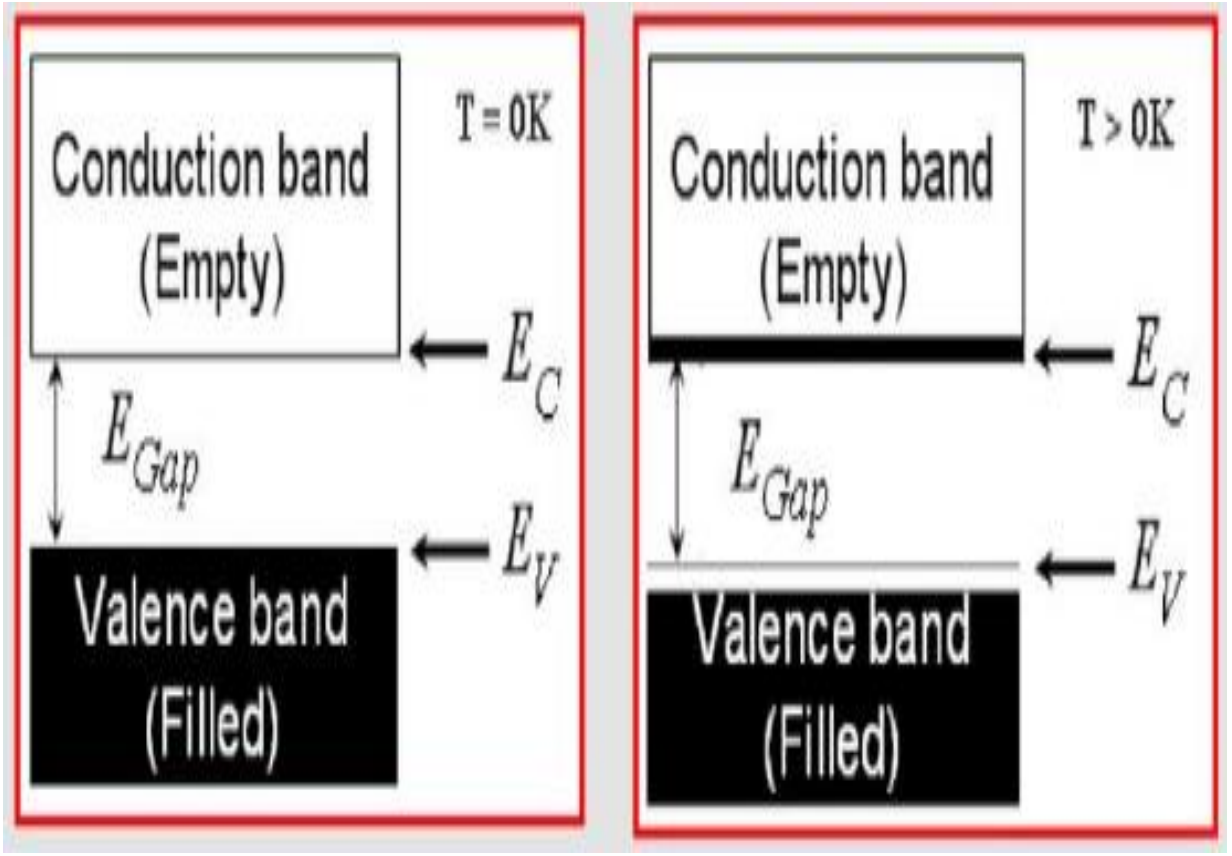
Metals, Semiconductors and Insulators

Semiconductor

1. In Semiconductor - the Energy BandGap (Eg) is smaller between Conduction Band and Valence Band than in insulators.
   Si -- Eg = 1.1eV

2. At 0K, Semiconductor behave as an Insulator.
3. At T> 0K, Semiconductor behave as an Metal

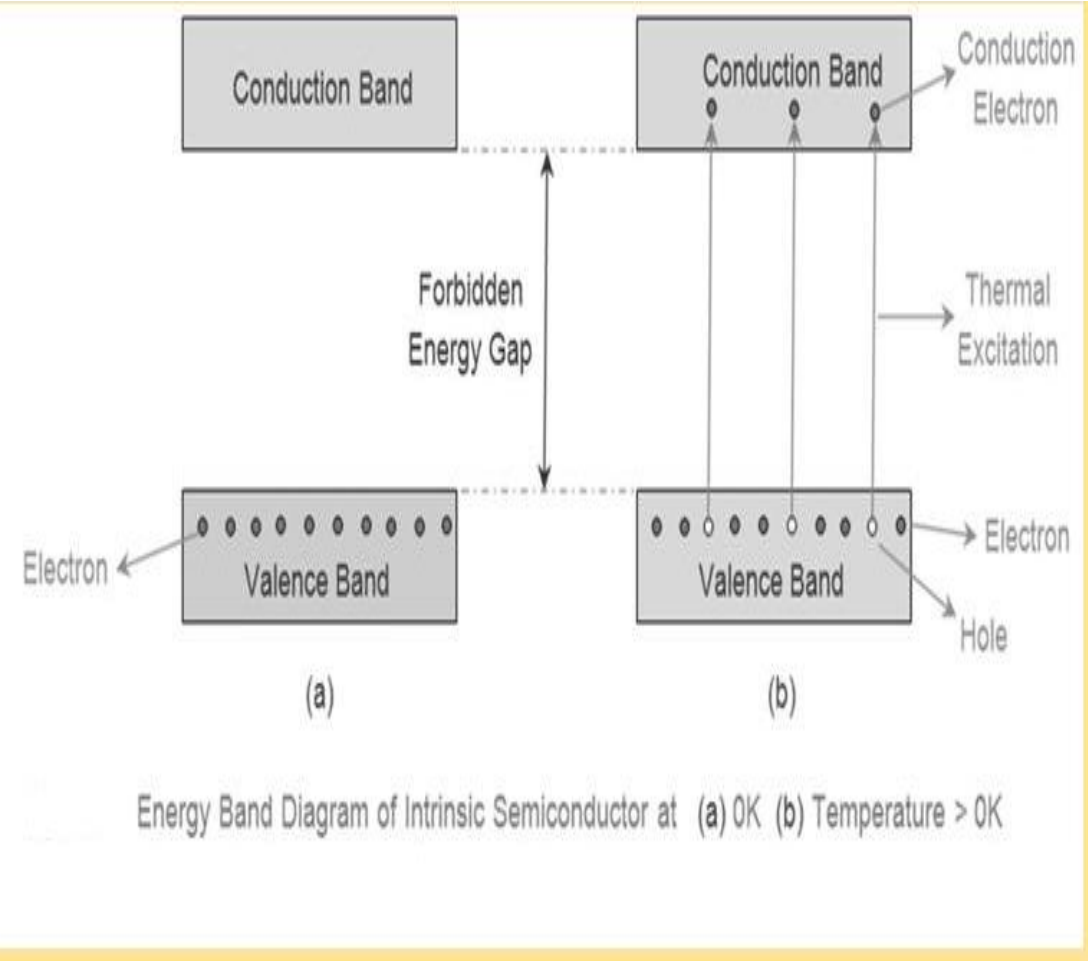
Energy Diagram of Semiconductor



Metals, Semiconductors and Insulators

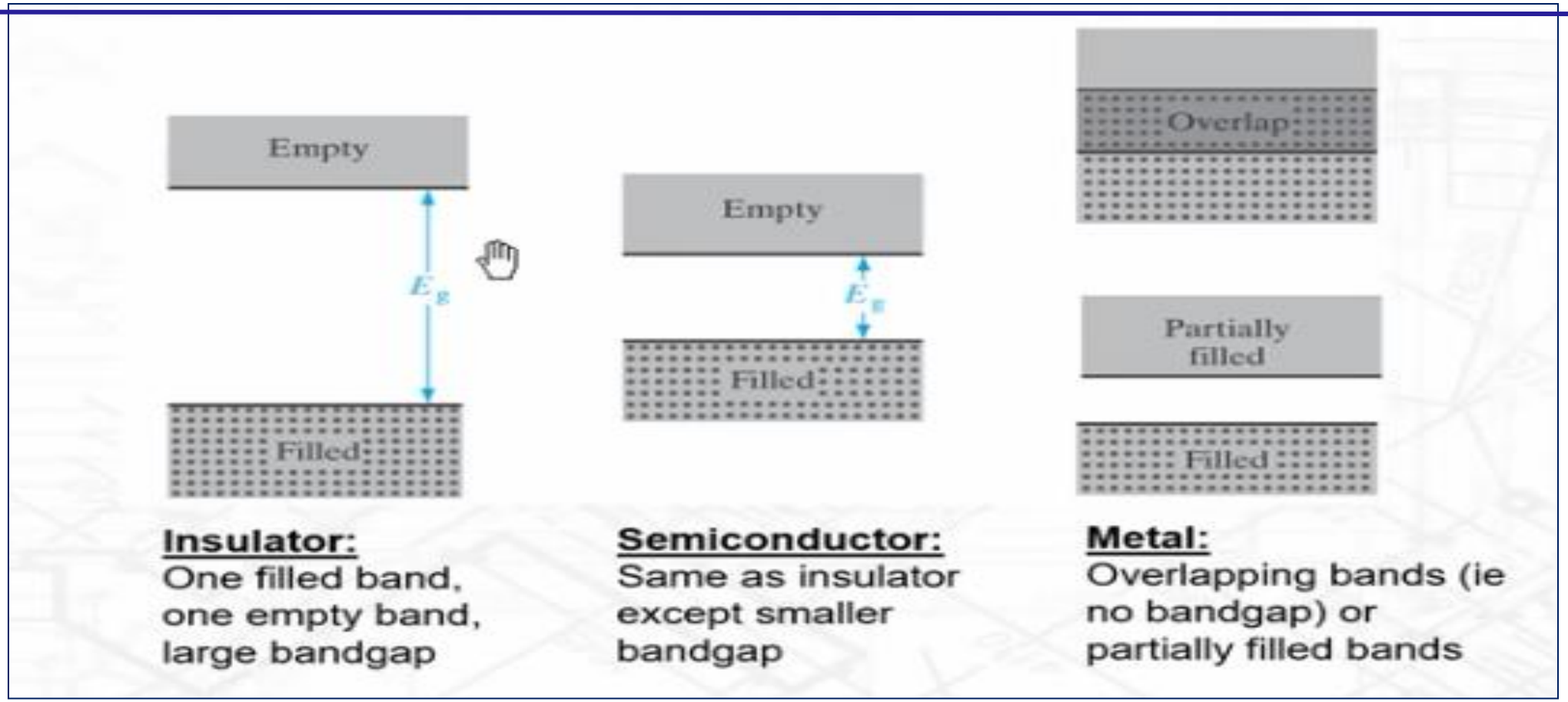
Semiconductor

1. A small fraction of the electrons is thermally excited into the conduction band. These electrons carry current just as in metals.
2. The smaller the gap the more electrons in conduction band at a given temperature.
3. Resistivity decreases with temperature due to higher concentration of electrons in conduction band



Energy Band Diagram of Intrinsic Semiconductor at (a) 0K (b) Temperature > 0K

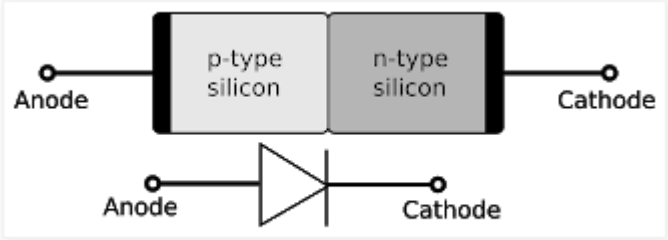
The Energy Band of Metals, Semiconductors and Insulators

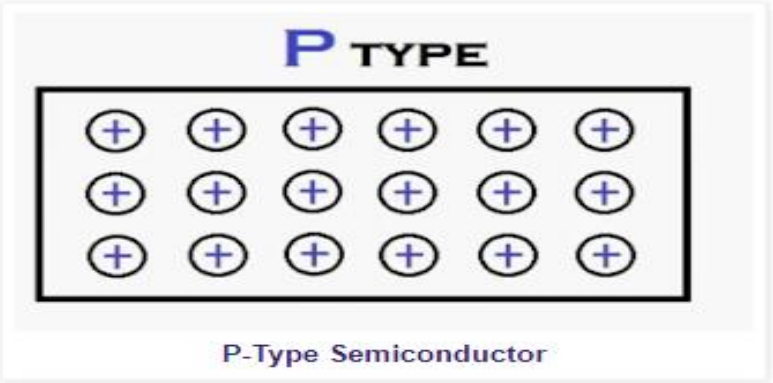


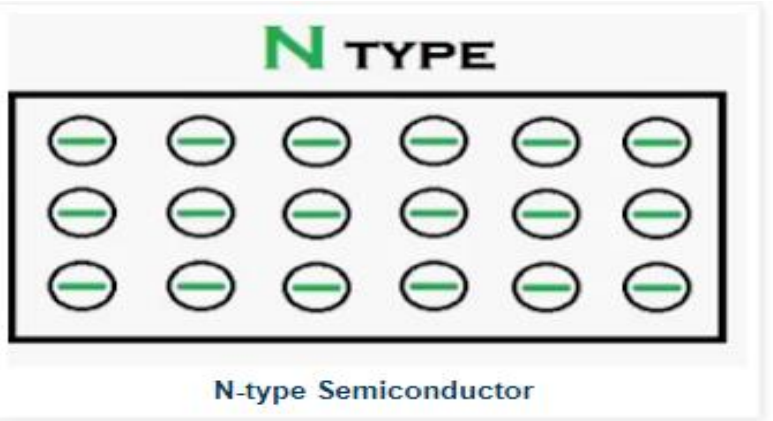
PN JUNCTION DIODE

What is a PN Junction?

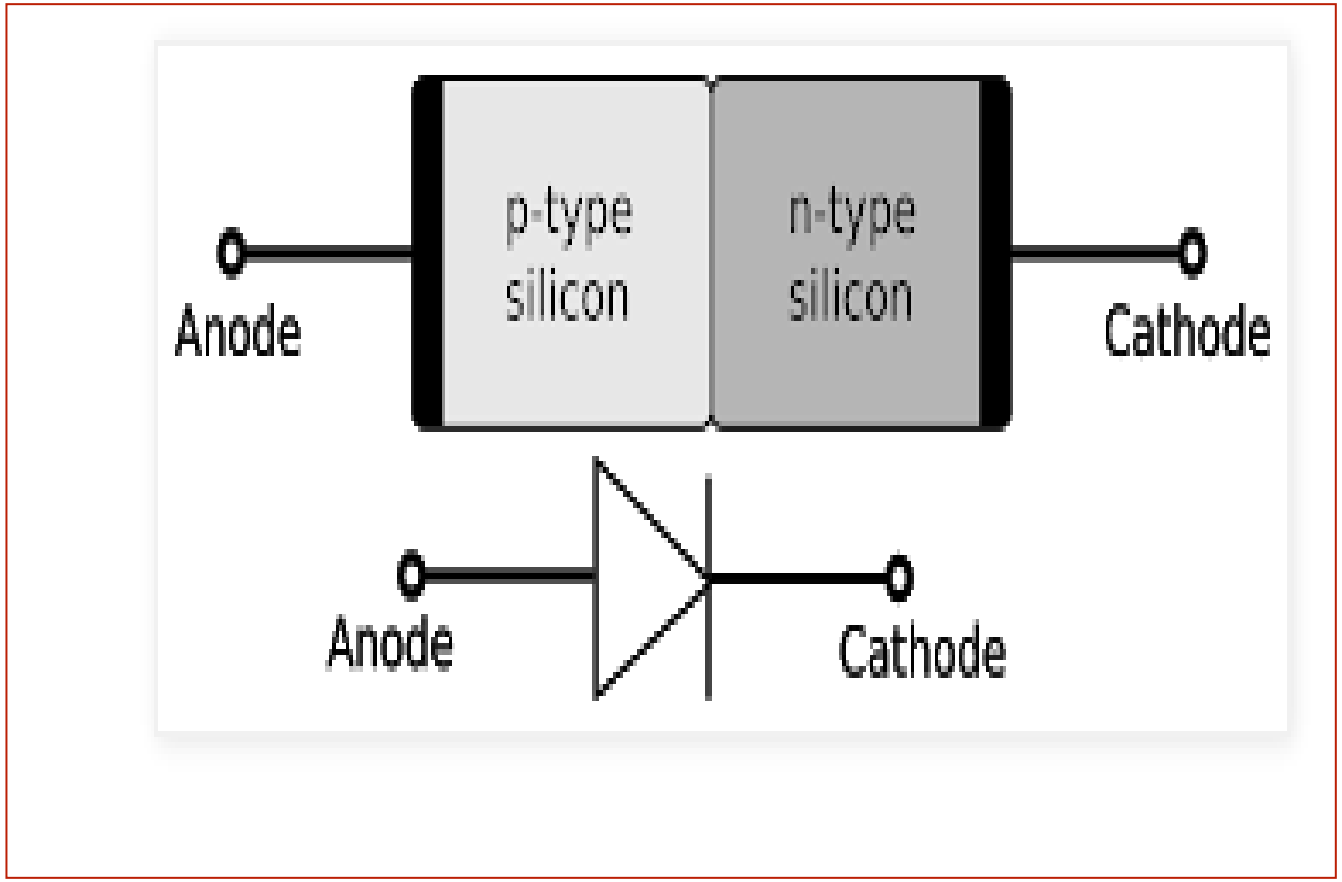
A PN junction is a device formed by joining p-type (doped with B, Al) with n-type (doped with P, As, Sb) semiconductors and separated by a thin junction is called PN Junction diode or junction diode.







The PN Junction Diode

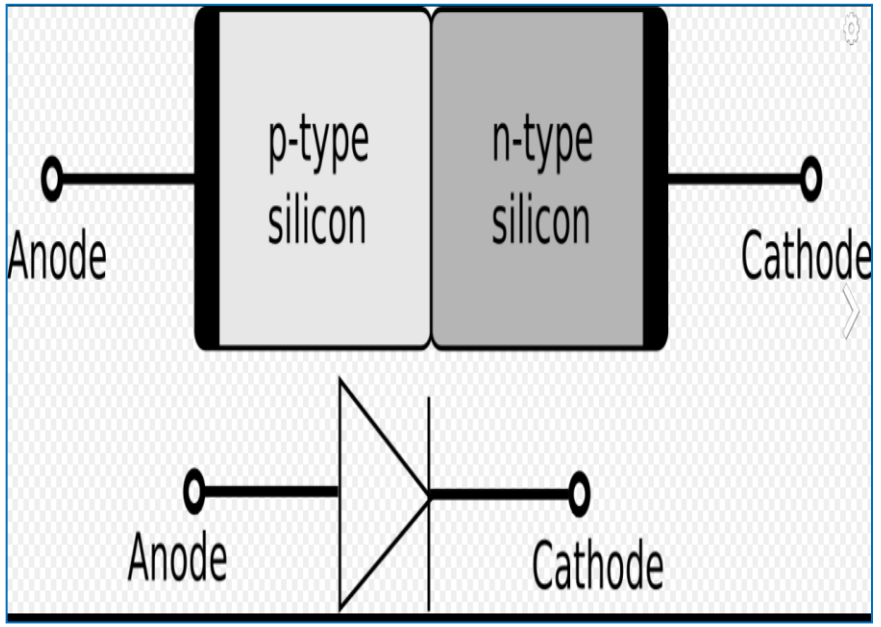


PN JUNCTION DIODE

- In PN junction diode, N is at right and P is at left.
- Majority carriers

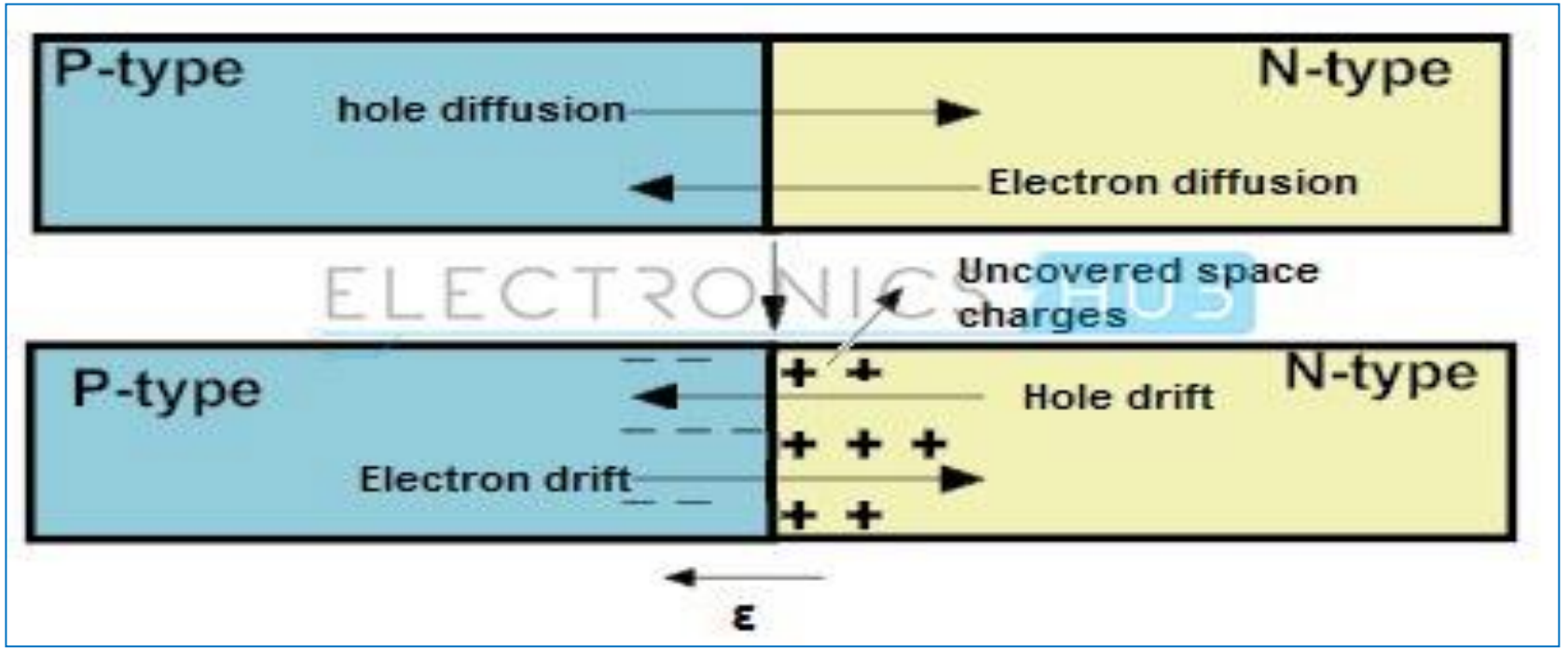
  N region -- electrons

  P region -- holes

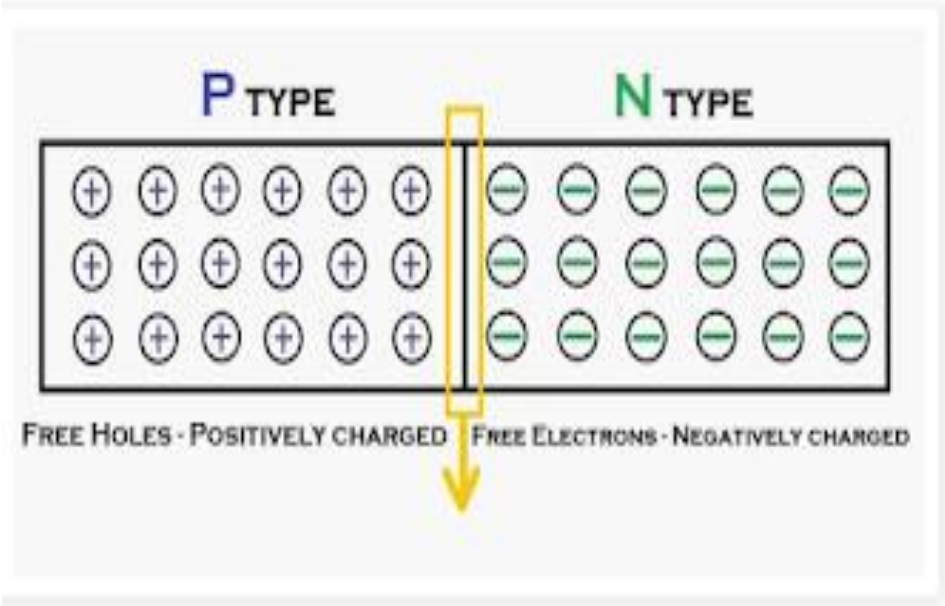


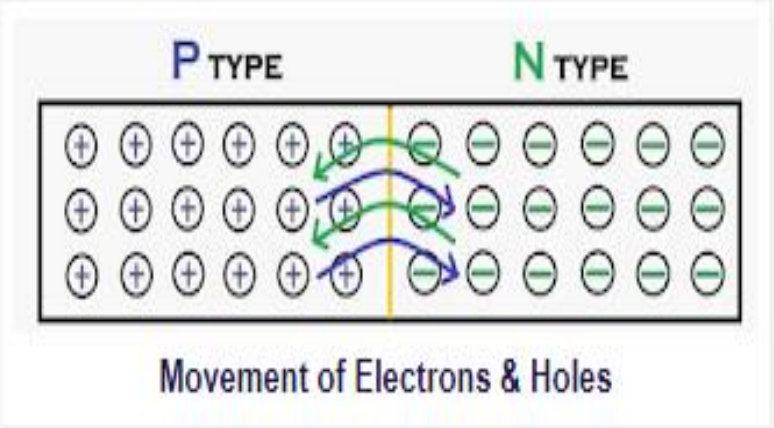
PN JUNCTION DIODE

Formation of depletion layer

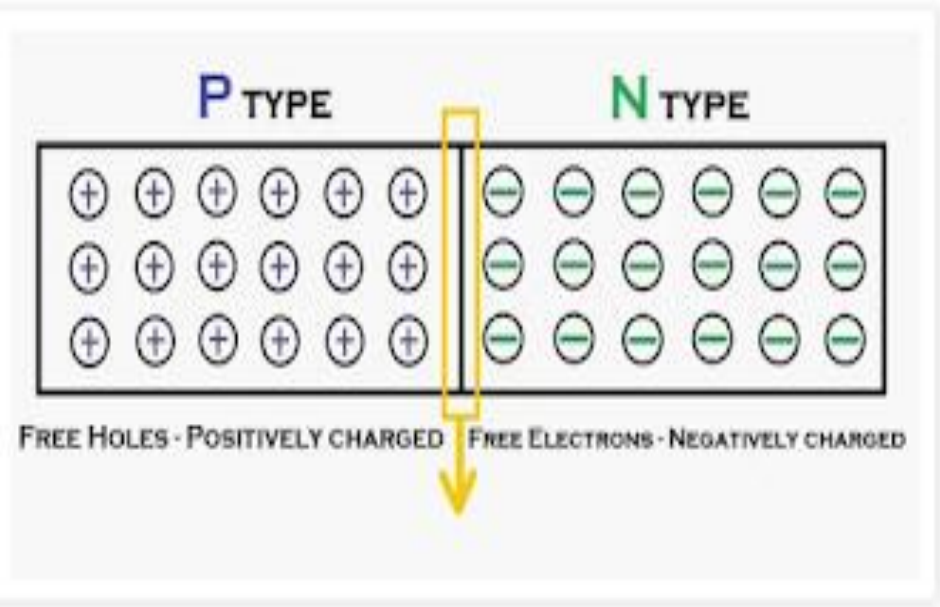


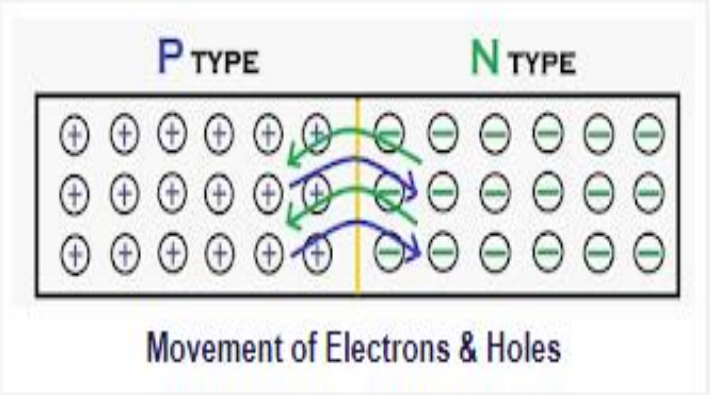
The PN Junction Diode

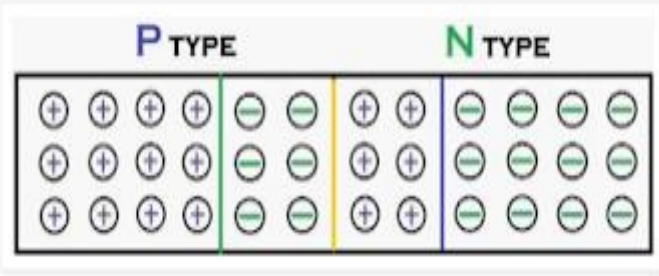




The PN Junction Diode

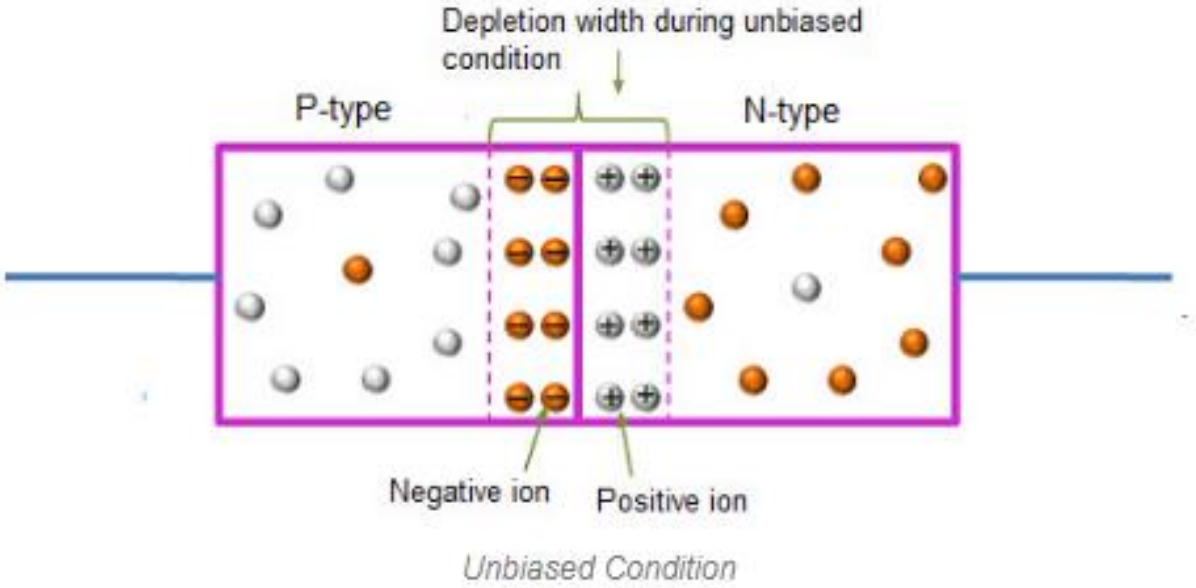






The PN Junction

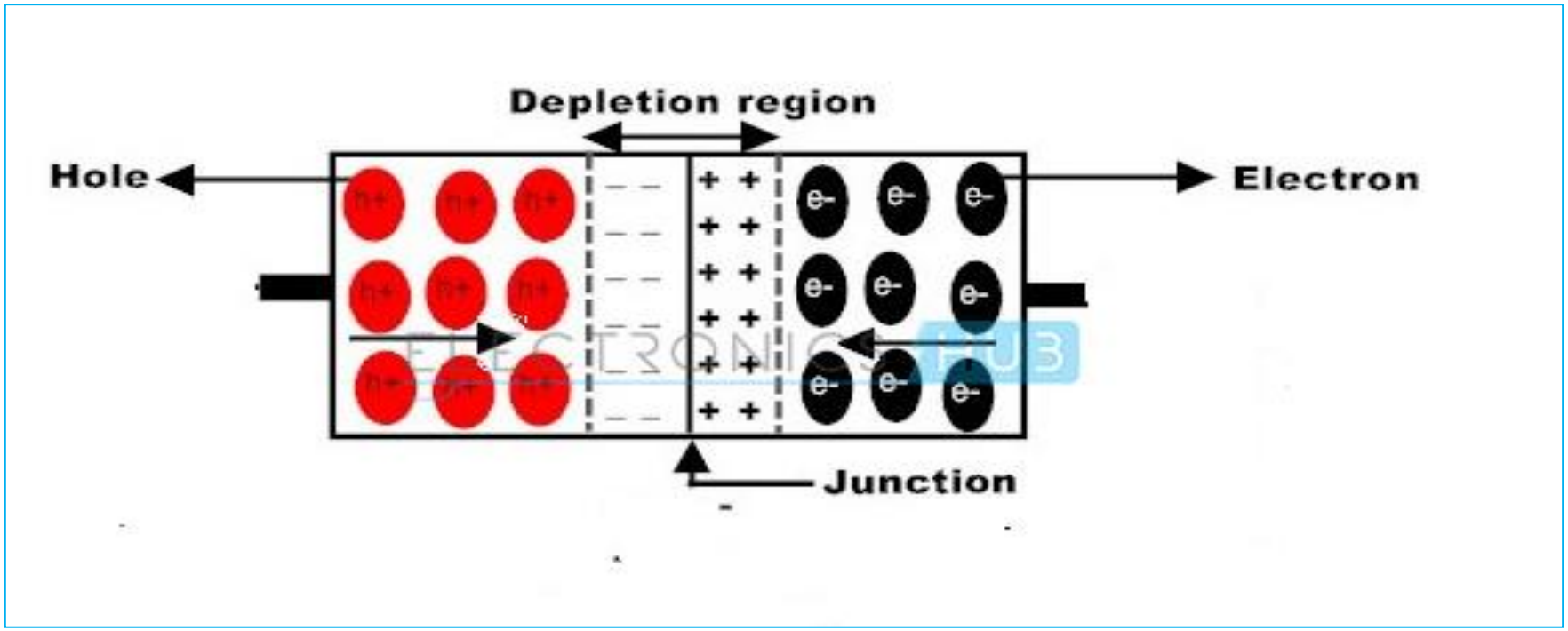
- The PN Junction Diode UnBiased



Unbiased Condition

PN JUNCTION DIODE

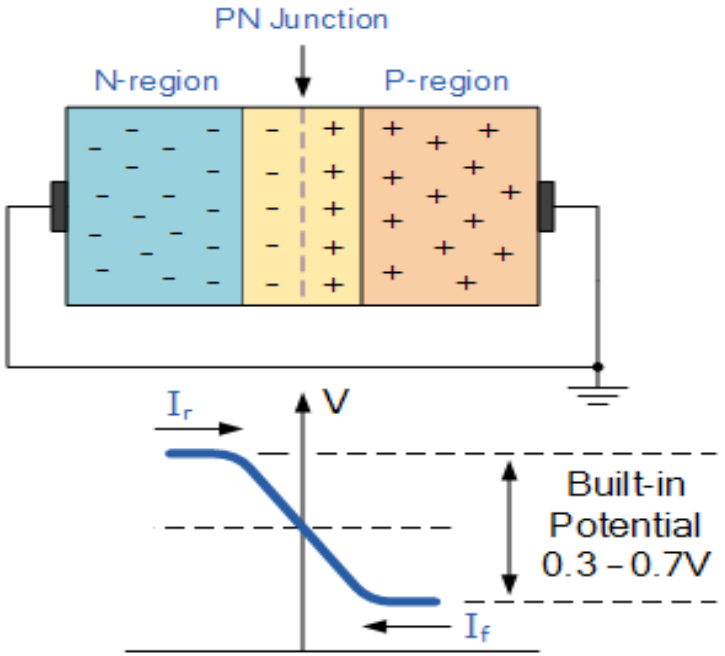
Formation of depletion layer



PN JUNCTION DIODE

POTENTIAL BARRIER

- The electrons in the N region have to climb the potential hill in order to reach the P region
- Electrons trying to cross from the N region to P region experience a retarding field of the battery and therefore repelled. Similarly for holes from P region.
- Potential thus produced are called ..**potential barrier**
- Ge..0.3 V Si ..0.7V



PN JUNCTION WORKING MODES

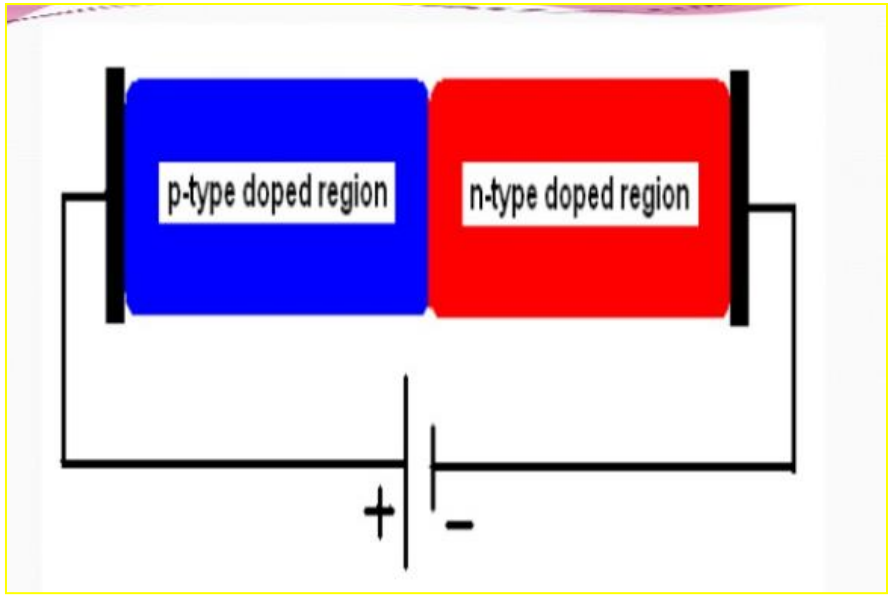
PN junction can basically work in two modes, (***A battery is connected to the diode***)

- **forward bias mode** (positive terminal connected to p-region and negative terminal connected to n region)

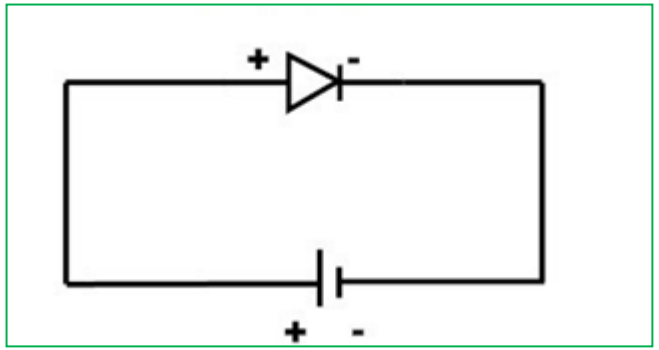
- ***reverse bias mode*** (negative terminal connected to p-region and positive terminal connected to n region)

PN JUNCTION DIODE

- Forward Bias Connection

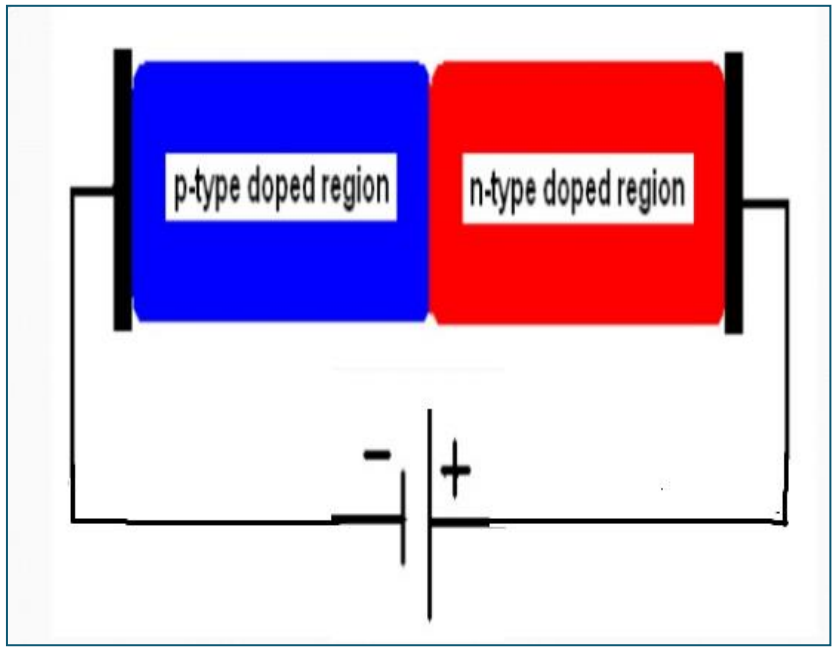


- Forward Bias Connection

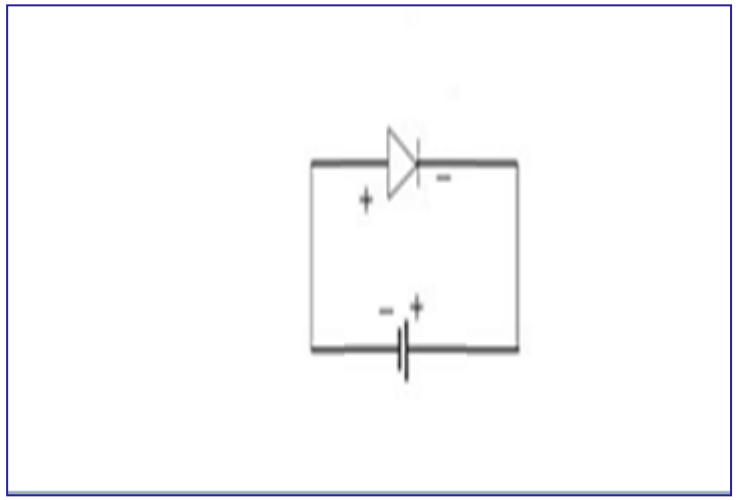


PN JUNCTION DIODE

- Reverse Bias Connection

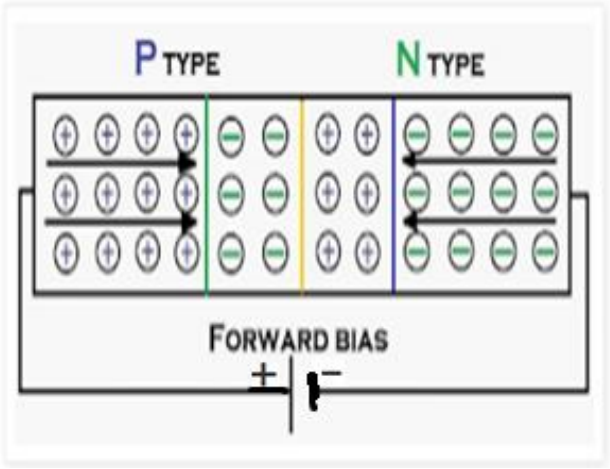


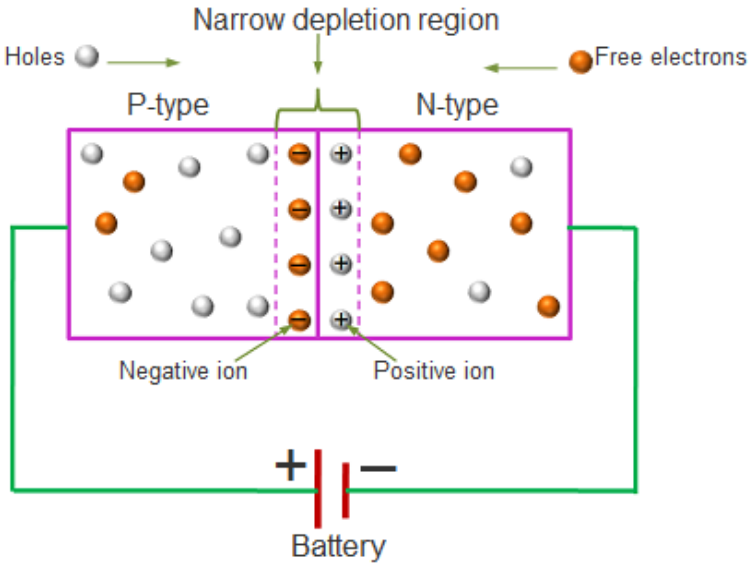
- Reverse Bias Connection



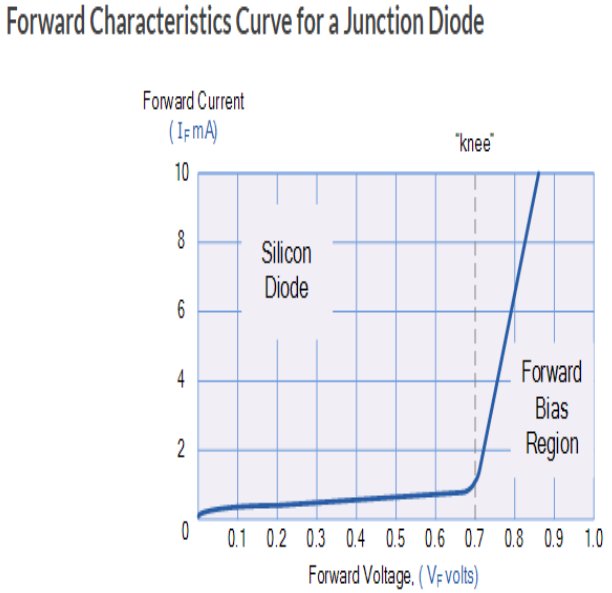
The PN Junction

- Forward Bias PN Junction Diode



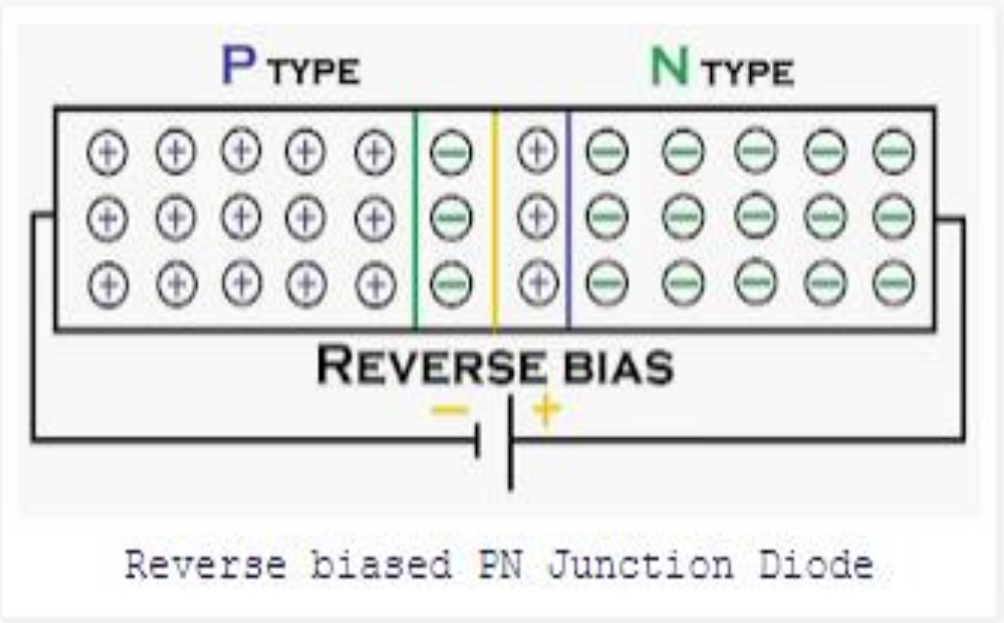


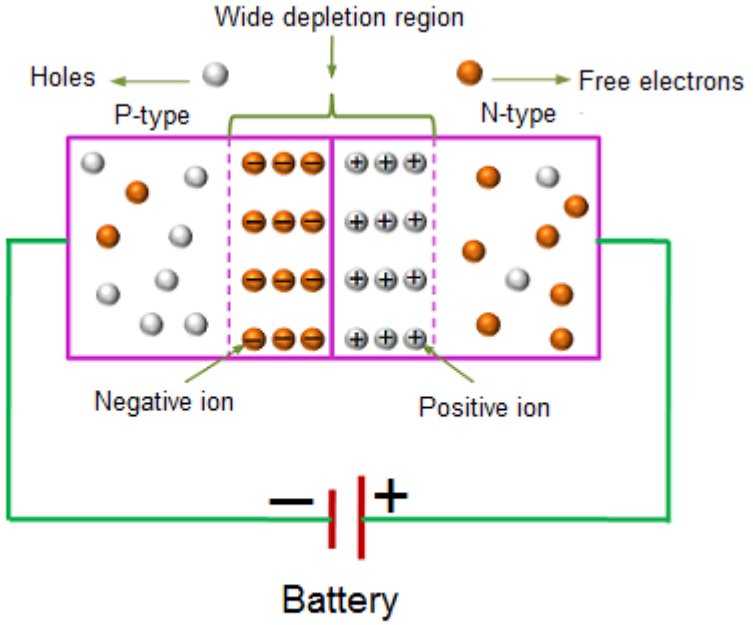
Forward bias



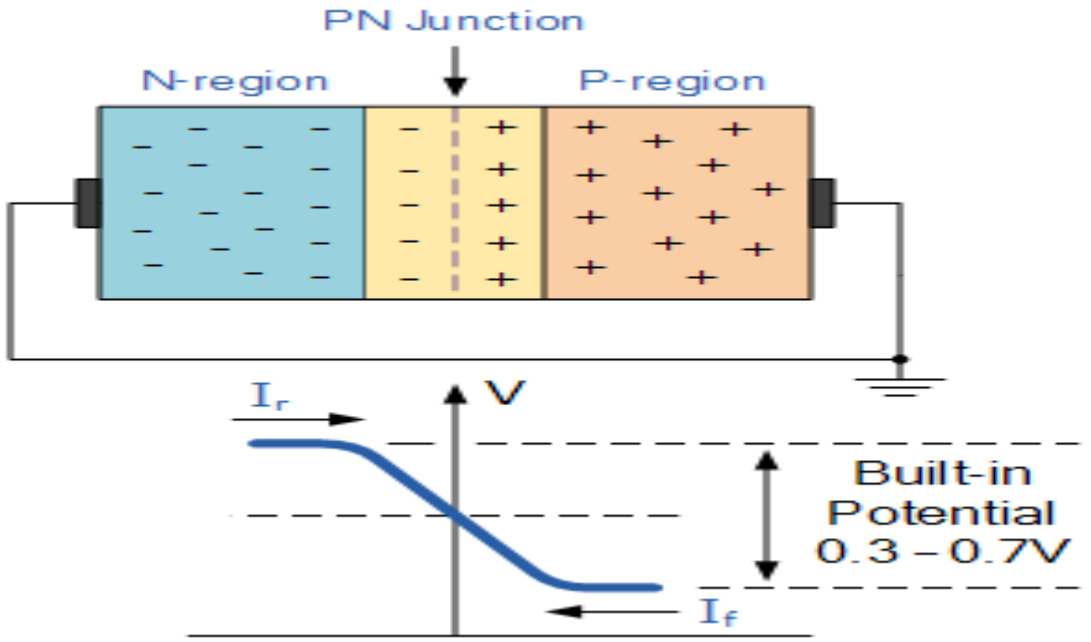
The PN Junction

- Reverse Bias PN Junction Diode

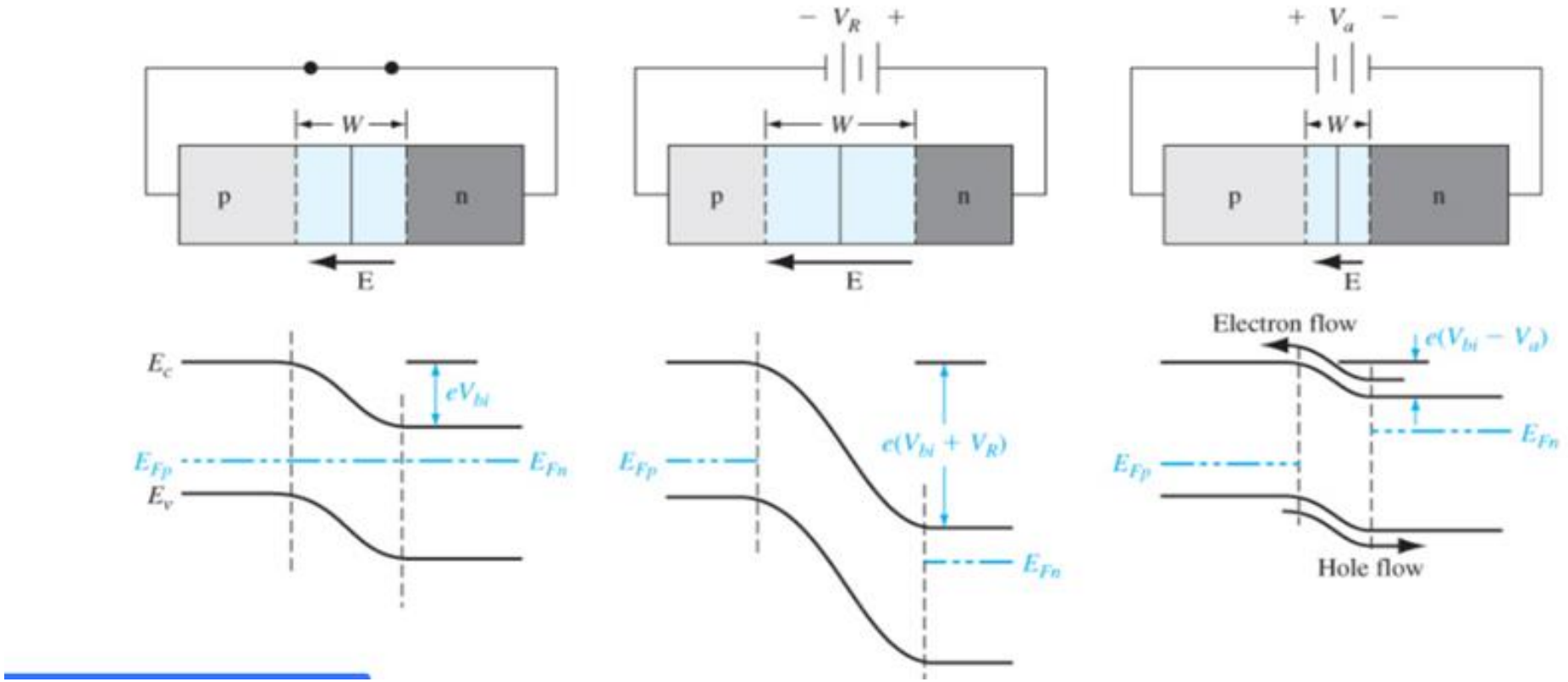




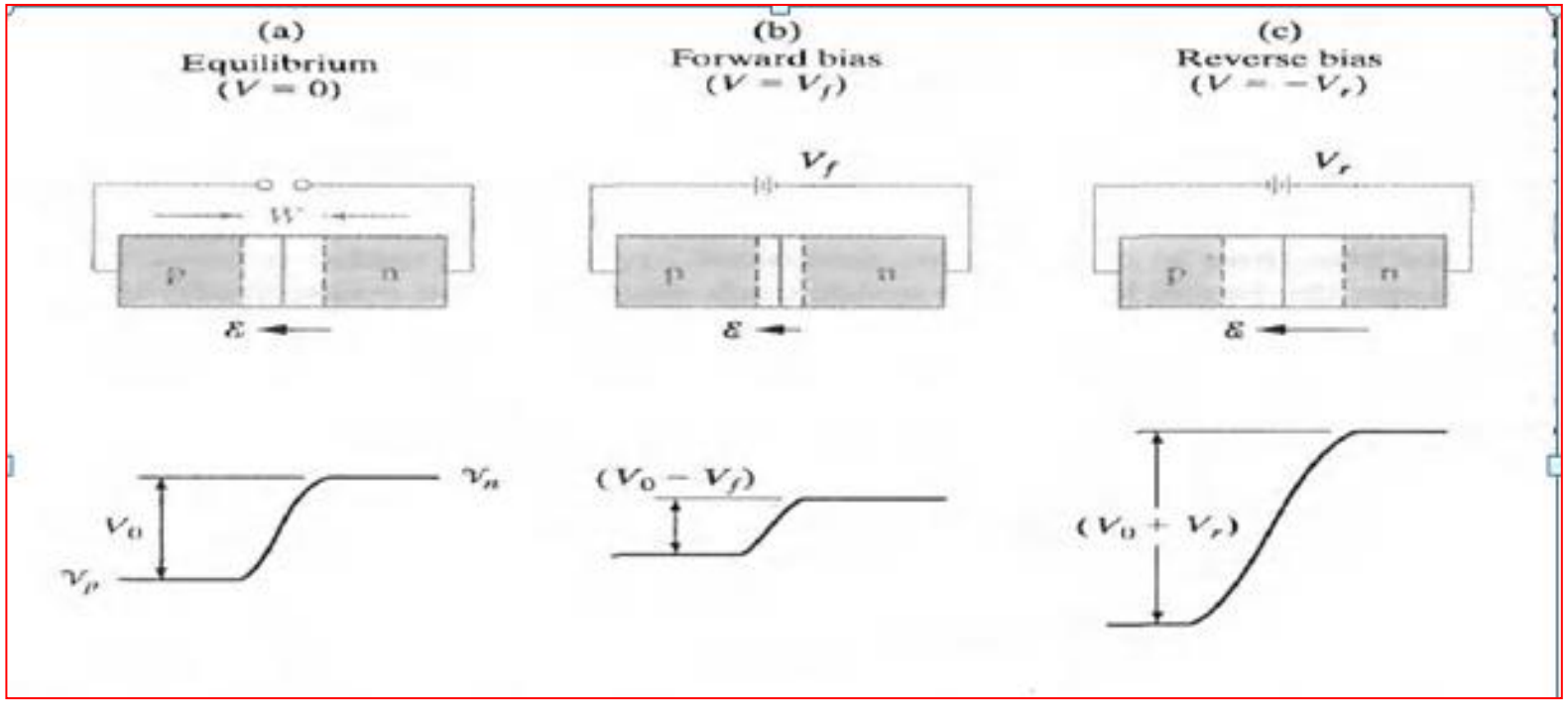
The PN Junction



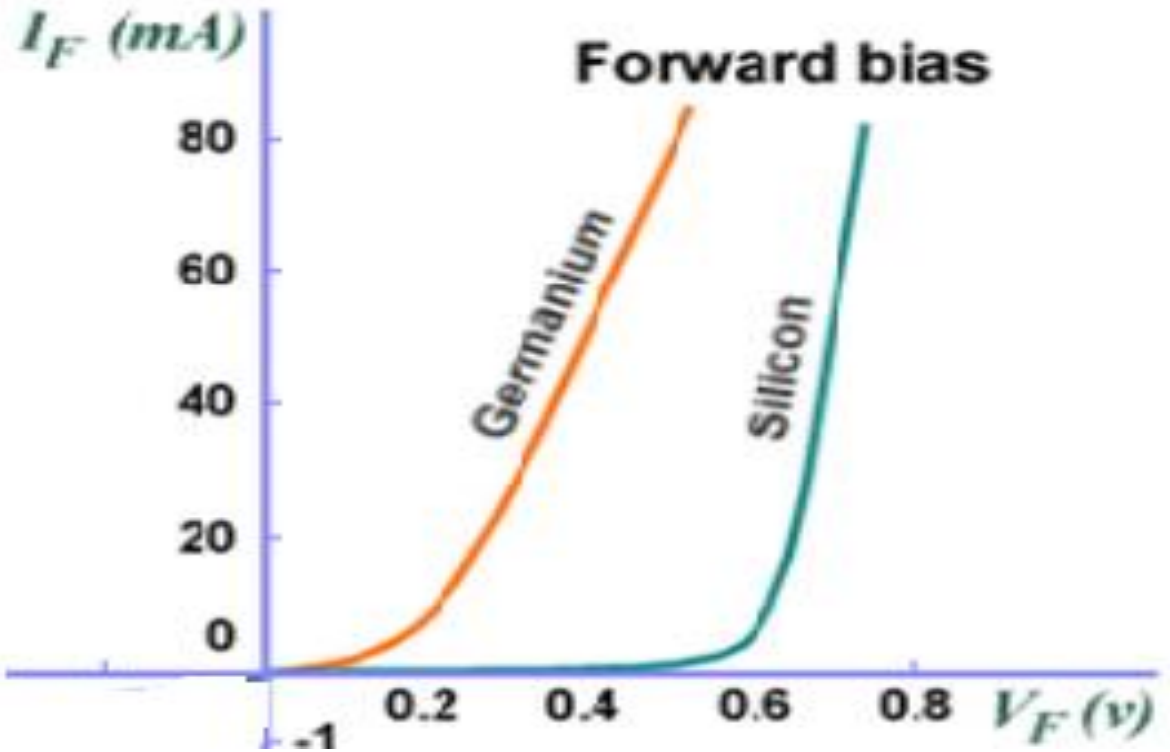
Energy Band Bending Diagram PN Junction Diode



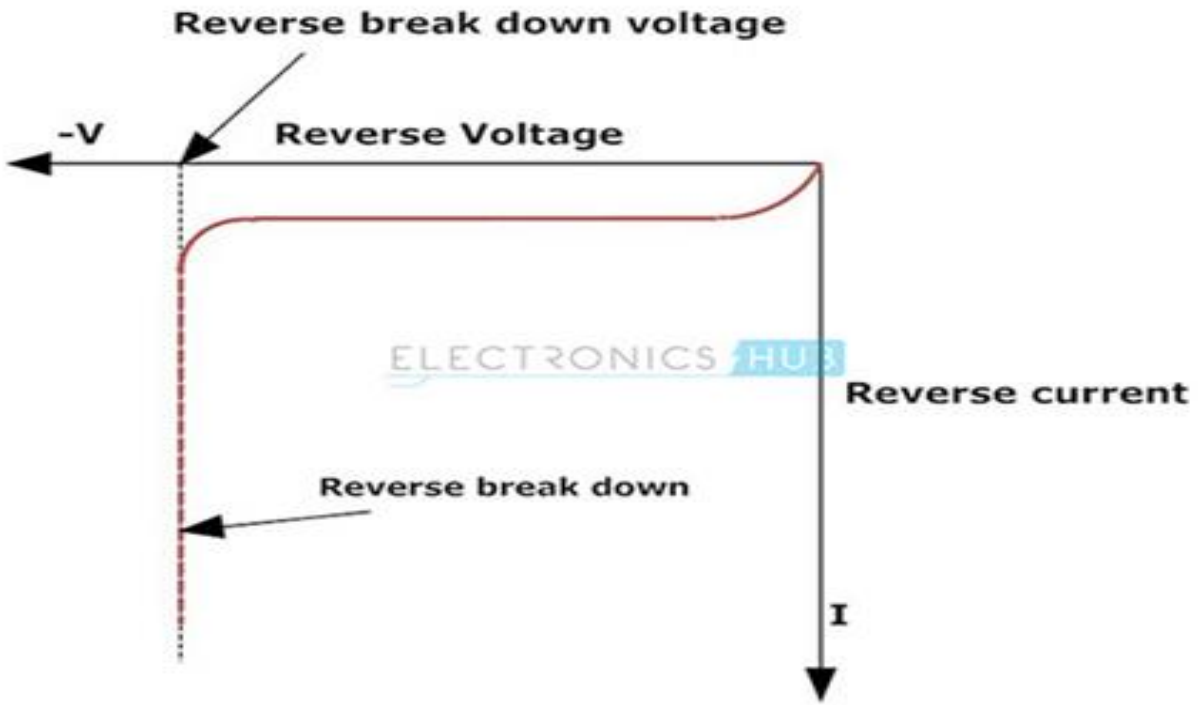
Energy Band Bending Diagram PN Junction Diode



Forward Diode Characteristics



Reverse Diode Characteristics



The PN Junction

APPLICATIONS

- ....as rectifiers to convert AC into DC.
- As an switch in computer circuits.
- As detectors in radios to detect audio signals
- As LED to emit different colours.

The PN Junction

Automatic switch

- When the diode is forward bias ,the switch is CLOSED.
- When it is reverse biased , it is OPEN

Thank You

HAVE A NICE DAY