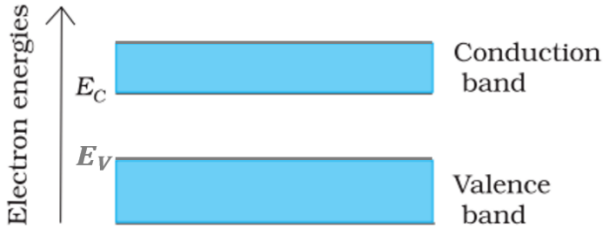
Chapter 14

Semiconductor Electronics:

Materials ,Devices and Simple Circuits

1.Draw energy bands in solids

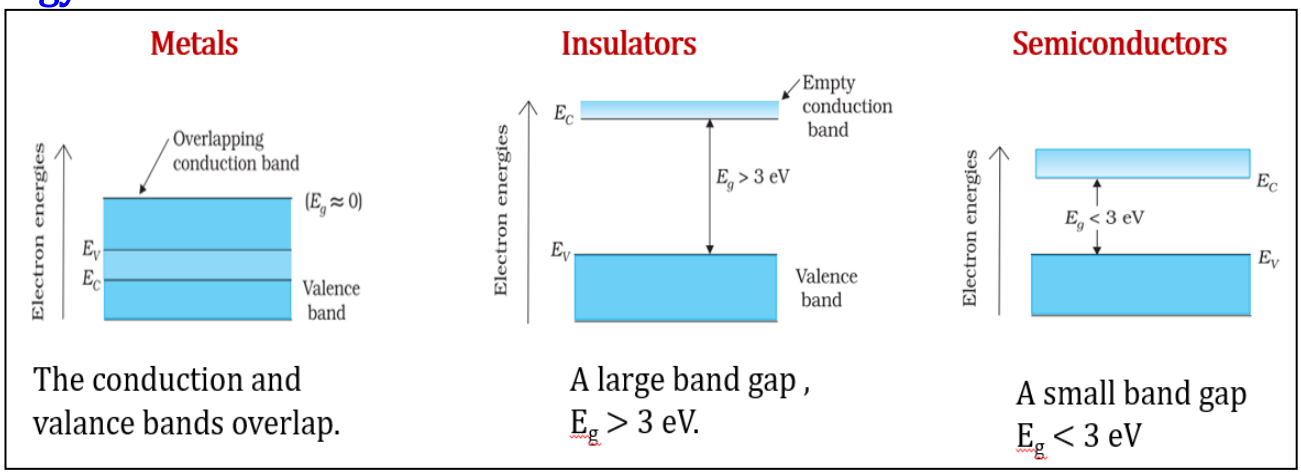


2.Define energy gap or band gap. Write the unit in which band gap is measured.

The energy difference between the top of the valence band and bottom of the conduction band is called the energy band gap (Energy gap E_g).

It is measured in electron volt.

3.Classification of Metals, Conductors and Semiconductors on the basis of energy bands



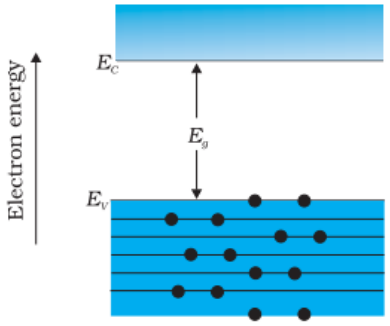
4.What are Intrinsic Semiconductors?

Pure semiconductors are called 'intrinsic semiconductors'.

$$n_e = n_h = n_i$$

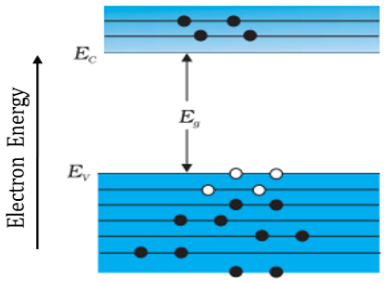
5.Draw the energy-band diagram of an intrinsic semiconductor at t=0k

An intrinsic semiconductor will behave like an insulator at T = 0 K .



6.Draw the energy-band diagram of an intrinsic semiconductor at t > 0k

At temperatures (T > 0K), some electrons are excited from the valence band to the conduction band, leaving equal number of holes there.



7.What are Extrinsic Semiconductor?

When a small amount of a suitable impurity is added to the pure semiconductor, the conductivity of the semiconductor is increased . Such materials are known as extrinsic semiconductors or impurity semiconductors. There are two types of extrinsic semiconductors –

(i) n-type semiconductor
(ii) p-type semiconductor

8.What is doping and dopants?

The deliberate addition of a desirable impurity is called doping and the impurity atoms are called dopants. Such a material is also called a doped semiconductor.

9.What are n-type semiconductors?

n-type semiconductor is obtained by doping Si or Ge with pentavalent atoms (donors) like Arsenic (As), Antimony (Sb), Phosphorous (P),etc.

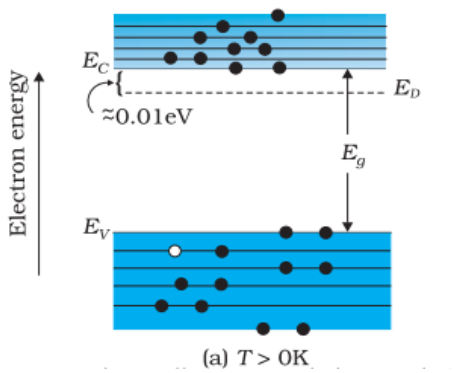
For n-type semiconductors, $n_e >> n_h$

10.What are p-type semiconductors?

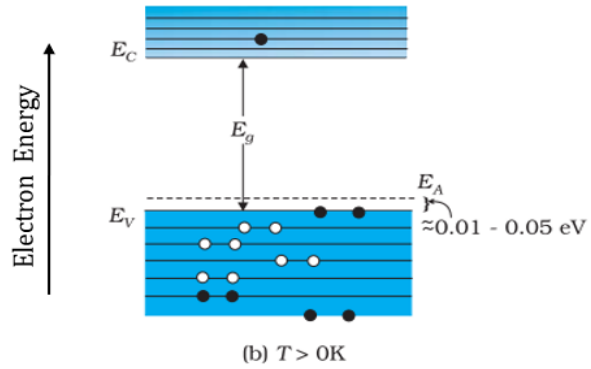
p-type semiconductor is obtained when Si or Ge is doped with a trivalent impurity like Indium (In), Boron (B), Aluminium (Al), etc.

For p-type semiconductors, $n_h >> n_e$

11.Draw the energy bands of n-type semiconductor at T > 0K

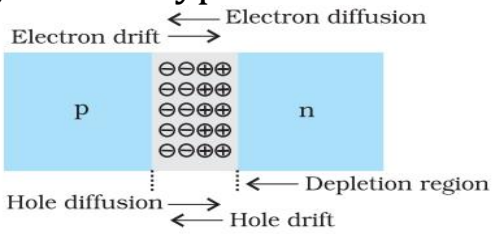


12.Draw the energy bands of p-type semiconductor at T > 0K



13.How a p-n junction is formed?

A p-n junction can be formed by adding a small quantity of pendavalent impurity to a p-type semiconductor or by adding a small quantity of trivalent impurity to an n-type semiconductor.



14.What is Diffusion current?

The holes diffuse from p-side to n-side (p → n) and electrons diffuse from n-side to p-side (n → p). This motion of charge carriers give rise to Diffusion current across the junction.

15.What is drift?

The motion of minority charge carriers across p-n junction due to electricfield is called called drift.

16.What is Depletion region (Depletion layer)

The space-charge region on either side of the junction together is known as depletion region. The depletion layer consist of immobile ion-cores and no free electrons or holes. This is responsible for a junction potential barrier.

17.Barrier Potential

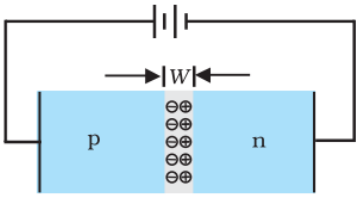
The loss of electrons from the n-region and the gain of electron by the p-region causes a difference of potential across the junction of the two regions. Since this potential tends to prevent the movement of electron from the n region into the p region, it is called a barrier potential.

The barrier potential of a Ge diode is 0.2Vand that of a Si diode is 0.7V.

18.Draw the symbol of a p-n junction Diode

19.What is forward biasing of a p-n junction diode ?

If p-side of the diode is connected to the positive terminal and n-side to the negative terminal of the battery, it is said to be forward biased.

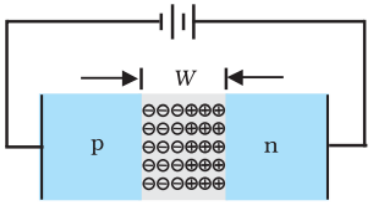


20.Write specific features of forward biased p-n junction diode.

- The depletion layer width decreases and the barrier height is reduced.
- The effective barrier height is $(V_0 - V)$.
- The motion of majority carriers on either side gives rise to diffusion current.
- The magnitude of this current is usually in mA.

21.What is reverse biasing of a p-n junction diode ?

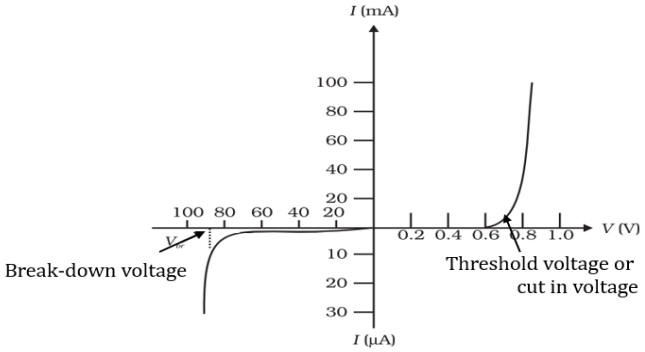
If n-side of the diode is connected to the positive terminal and p-side to the negative terminal of the battery, it is said to be reverse biased.



22.Write specific features of reverse biased p-n junction diode.

- The depletion layer width increases and the barrier height is incresaed.
- The effective barrier height is $(V_0 + V)$..
- The drift of minority carriers gives rise to drift current.
- The drift current is of the order of a few μA.

23.Draw the V-I characteristics of a silicon diode and mark threshold voltage and break-down voltage.



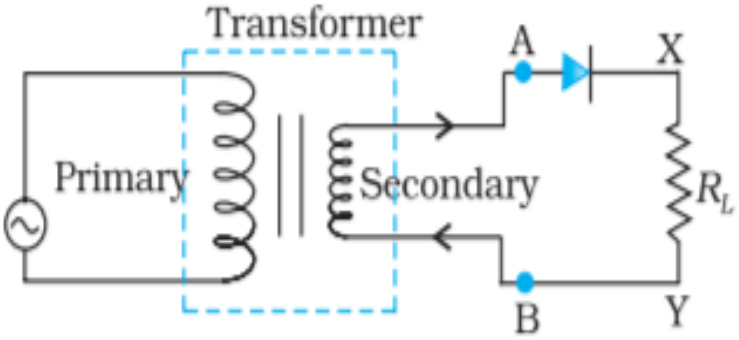
24.Define threshold voltage of a p-n junction diode.

The forward voltage beyond which the diode current increases significantly is called threshold voltage or cut-in voltage or knee voltage.

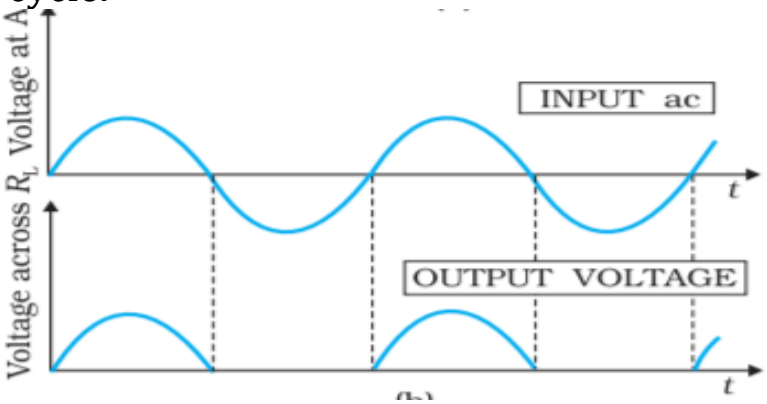
25.Define break down voltage of a p-n junction diode.

The reverse voltage at which the reverse current increases suddenly is called break-down voltage.

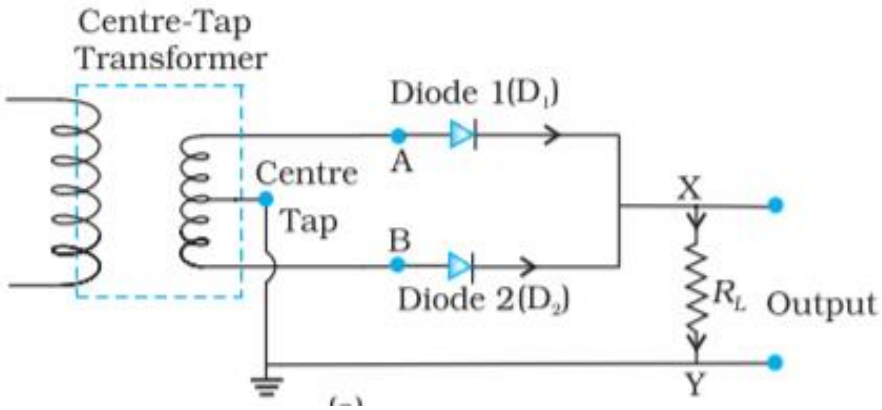
26.Explain a half wave rectifier Draw the input and output voltage waveforms.



In the positive half-cycle of ac there is a current through the load resistor R_L and we get an output voltage, whereas there is no current in the negative half cycle.



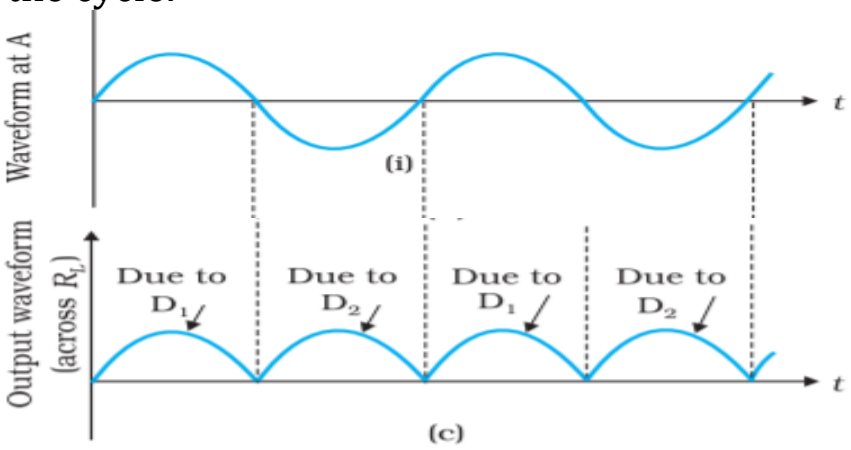
27. Explain a full wave rectifier . Draw the input and output voltage waveforms.



During this positive half cycle, diode D_1 gets forward biased and conducts ,while D_2 being reverse biased is not conducting. Hence we get an output current and a output voltage across the load resistor R_L.

During negative half cycle, diode D_1 would not conduct but diode D_2 conducts, giving an output current and output voltage across R_L in the same directionas in positive half.

Thus, we get output voltage during both the positive as well as the negative half of the cycle.



28.What are filters? Draw the input and output waveforms of filter circuit

The cicuits that filter out the ac ripple and give a pure dc voltage are called filters.