CHAPTER

14

Semiconductors

Semiconductors

(i) Semiconductors have conductivity between conductors and insulators. At low temperatures, their conductivity is low and with rise in temperature their conductivity increases.

(ii) In all solids, different energy levels combine to form two bands valence band and conduction band.

(iii) Valence band (*VB*) contains valence electrons. It may be partially or fully filled.

(iv) Conduction band (*CB*) contains free electrons. It may be empty or partially filled.

(v) The energy difference between valence band and conduction band is called forbidden energy gap.

(vi) The forbidden energy gap is less for conductors and large for insulators and in between for semiconductors.

(vii) Pure semiconductors are called intrinsic semi conductor Ex. Silicon and Germanium (Si and Ge).

P-N Junctions Diode

(i) A *p*-*n* junction is a single piece of semiconductor, one half of which is *p*-type and the other half is *n*-type.

(ii) The region near the junction is called depletion layer.

(iii) There are two types of connections of a diode
   (*a*) Forward bias
   (*b*) Reverse bias

(iv) When *p*-type is connected to positive and *n*-type connected to negative terminal then it is forward biased.

(v) In forward bias the diode offers minimum resistance and depletion region becomes narrowed. It is similar to 'ON' in an electrical switch.

(vi) In reverse bias *p*-type is connected to negative terminal and *n*-type is connected to positive terminal.

(vii) In reverse bias the diode offers maximum resistance, does not conduct and depletion region becomes widened. It is similar to 'OFF' in an electrical switch.

Zener Diode

(i) A properly and highly doped *p*-*n* junction diode which operates in reverse bias condition is called 'Zener diode'.

(ii) Silicon is preferred for making Zener diodes.

(iii) Zener diode is operated in reverse bias, which operates at a voltage called 'Zener voltage'.

(iv) Zener diode is used as a 'Voltage regulator'.

Transistors

(i) Transistor means transfer resistor.

(ii) There are two types of transistors called
   (*a*) *npn* transistor
   (*b*) *pnp* transistor.

(iii) In transistor there are three terminals called emitter, base and collector.

(iv) Transistor works as an amplifier and switch.

(v) Current gain of common emitter configuration is the ratio of small change in collector current to a small change in base current when collector-emitter voltage is constant.

(vi) Amplifier is a device which converts weak signals to strong signals and this process of converting weak signals to strong signals is called amplification.

(vii) Amplifiers are of two types
   (*a*) Power amplifier
   (*b*) Voltage amplifier

(viii) The amplifier which is used to raise the power level is known as 'Power amplifier'.

(ix) The amplifier which is used to raise voltage level is known as 'Voltage amplifier'.

Important Formulae

(i) Rectifier efficiency $(\eta) = \dfrac{\text{dc output power}}{\text{ac input power}}$

(ii) Half wave rectifier efficiency $(\eta) = \dfrac{0.406 \times R_L}{r_f + R_L}$

r_f = diode forward resistance, R_L = load resistance

(iii) Full wave rectifier efficiency $\eta = \frac{0.812 \times R_L}{r_f + R_L}$

(iv) Current gain $\beta = \left[\frac{\Delta I_C}{\Delta I_B}\right]_{V_{CC}}$, $\alpha = \left(\frac{\Delta I_C}{\Delta I_E}\right)$

Relation between α and β, $\beta = \frac{\alpha}{1-\alpha}$

ΔI_C = Change in collector current, ΔI_B = Change in base current

(v) Amplification factor $A = \frac{V_0}{V_i}$

V_0 = Output voltage; V_i = Input voltage

(vi) Voltage gain $= \frac{\Delta V_{CE}}{\Delta V_{BE}} = \beta \times \frac{R_L}{R_{in}}$

ΔV_{CE} = Change in output voltage,
ΔV_{BE} = Change in input voltage

(vii) Power gain, A_p = Current gain × voltage gain $= \beta^2 \times \frac{R_L}{R_{in}}$