



Semiconductor Electronics Materials, Devices and Simple Circuits

Semiconductors

- (i) Semiconductors behave both like conductors and insulators they behave like conductors when temperature is increased. They behave like insulators at low temperature i.e. 0 Kelvin (0 K) Ex. silicon and Germanium.
- (ii) In all solids, different energy levels combine to form two bands.
- (iii) Valence band (*VB*) contains valence electrons which may be partially or fully filled.
- (iv) Conduction band (*CB*) contains free electrons which 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 semiconductor 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 connection of 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 it offers minimum resistance, depletion region is 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 it offers maximum resistance, does not conduct and depletion region is 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 terminal 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, 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 Formula

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

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

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, $A_p = \text{Current gain} \times \text{voltage gain} = \beta^2 \times \frac{R_L}{R_{in}}$