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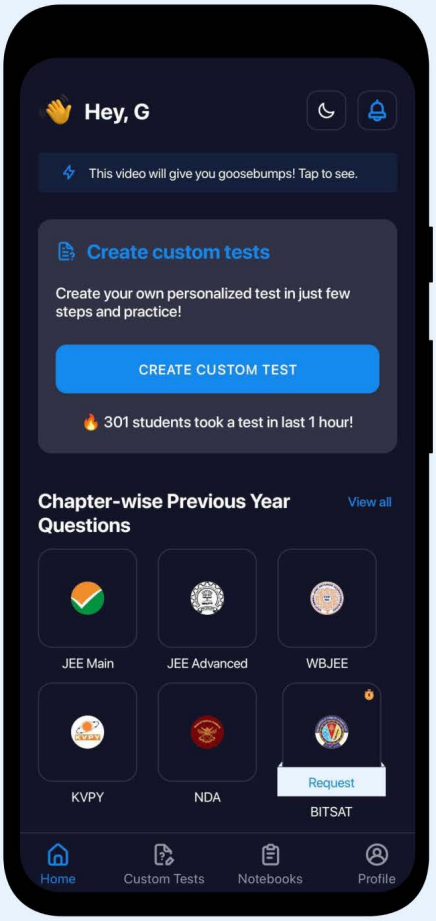

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SEMICONDUCTORS

Semiconductors : Electrical properties of which lie between conductor and insulators.

Semiconductors are materials that have a small energy gap of the order of 1eV. At 0K (absolute zero), the semiconductors behave like insulators.

Intrinsic Semiconductors (pure) : Semiconductor which are free from inpurity.

Intrinsic Semiconductors have an equal number of electrons in conduction band and holes in valence band

$n_e = n_h$

where n_e = number of electrons per unit volume

n_h = number of holes per unit volume

$n_e \times n_h = n_i^2$

n_i = intrinsic charge carrier density or intrinsic charge carrier concentration

Doped or Extrinsic Semiconductors : Semi conductors doped or added with certian impurity to increase its conductivity.

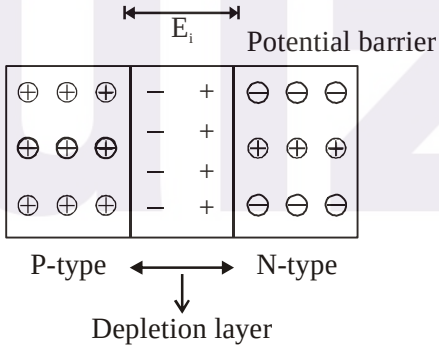
N-Type : In N type of semiconductor electrons are majority charge carriers and holes are minority charge carriers.

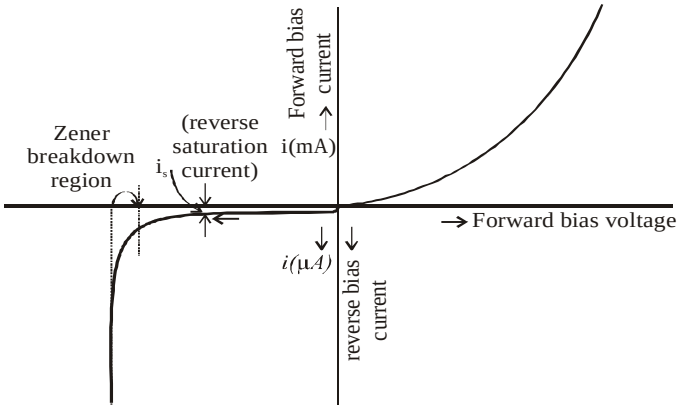
P Type : In P type semiconductors holes are majority charge carriers whereas electrons are minority charge carriers.

Semiconductor Devices

The P-N junction Diode :

P side of P-N junction has holes as a majority charge carriers and electrons as a minority charge carriers whereas N side has electrons as a majority charge carriers and holes as a minority charge carriers. holes diffuse from P side to N side whereas electrons diffuse from N side to P side.





P-N Junction Characteristics

Dynamic Resistance :

$$R = \frac{\Delta V}{\Delta i}$$

Where ΔV denotes a small change in the applied potential difference and Δi denotes corresponding small change in current.

Dynamic Resistance is equal to the reciprocal of the slope of the i-V characteristic.

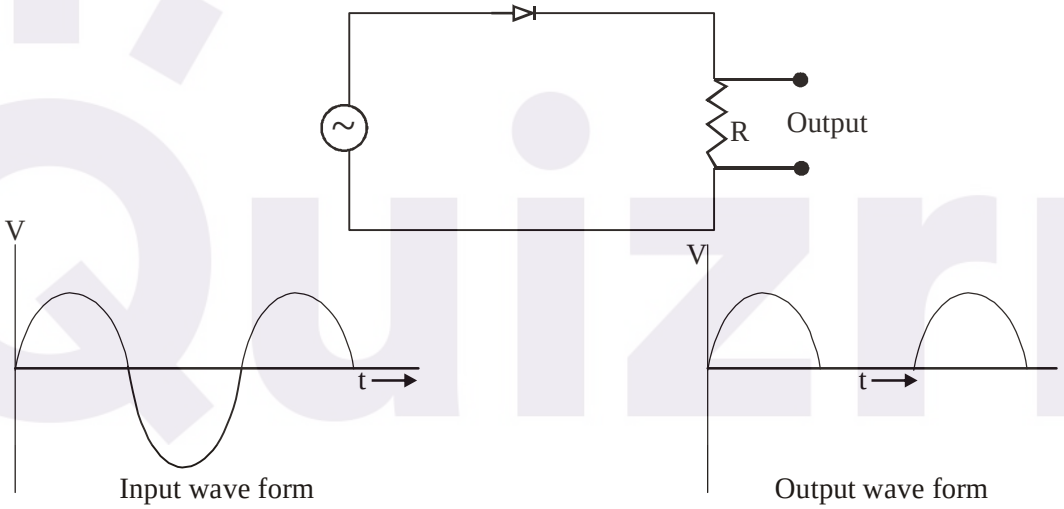
Photodiode : When a light of proper wavelength falls on the junction, new electron-hole pairs are created. The number of charge carriers increases and hence the conductivity of the junction increases. If the junction is connected in some circuit, the current in the circuit is controlled by the intensity of the incident light.

Light-emitting Diode (LED) : When a conduction electron makes a transition to the valence band to fill up a hole in P-N junction, the extra energy is emitted as a photon. If the wavelength of this photon is in the visible range one can see the emitted light. Such a P-N junction is known as light emitting diode (LED).

Zener diode : A diode operated in Zener break down mode is called Zener diode. In this type of mode of operation current increases rapidly but voltage remains almost constant. Thus it is used to obtain constant voltage output.

P-N Junction as a Rectifier : PN Junction can be used to convert A.C into unidirectional current. (DC)

(a) Half wave rectifier



Input wave form

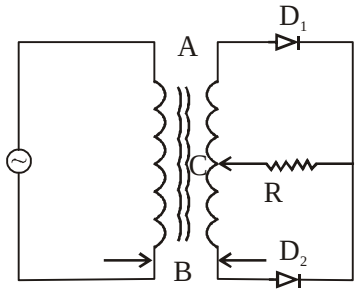
Output wave form

Average out put current = $\frac{I_o}{\pi}$

where I_o = amplitude of the input current

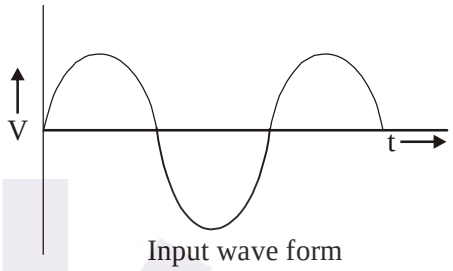
R.M.S. Value of output current = $\frac{I_o}{2}$

(b) Full Wave rectifier

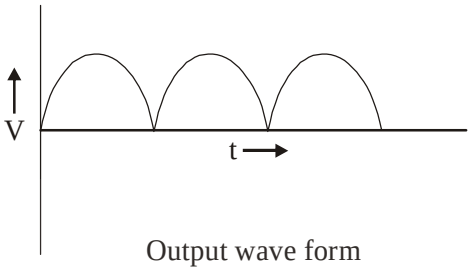


If $V_A > V_C > V_B$ D_1 Conducts

If $V_B > V_C > V_A$ D_2 Conducts



Input wave form



Output wave form

Average output current = $\frac{2I_o}{\pi}$

R.M.S. Value of output current = $\frac{I_o}{\sqrt{2}}$

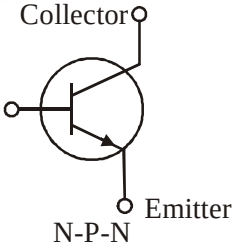
Junction transistor

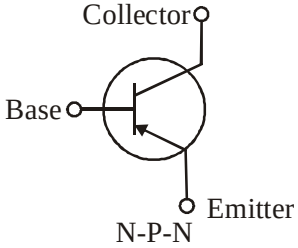
It has three terminals

(a) Emitter (b) Base (c) Collector

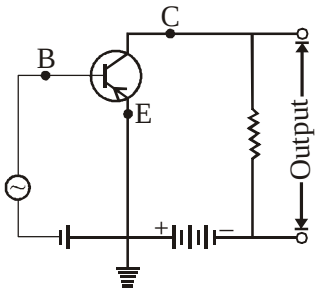
Emitter is heavily doped, collector is moderately doped and base is thin and lightly doped.

Symbol

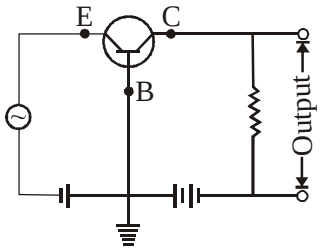




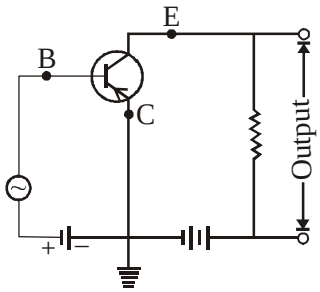
A transistor can be operated in three different modes. Common-emitter, common collector and common base.



Common Emitter



Common Base



Common Collector

Transistor as an Amplifier

1. Common base :

In this type amplifier, base to emitter junction is forward biased whereas base to collector is reverse biased

Transistor parameter

Current again $= \alpha = \frac{I_0}{I_E}$; AC current gain $= \frac{\Delta I_c}{\Delta I_e}$

Voltage gain $= A_v = \frac{\Delta v_0}{\Delta v_i} = \frac{I_0 R_{out}}{I_E R_{in}}$ = Current gain × Resistance gain $= \alpha \times \frac{R_0}{R_i}$

Where R_o = Resistance of the output circuit

R_i = Resistance of the input circuit

Power gain = α^2 × Resistance gain

2. Common emitter amplifier

Current gain $\beta = \frac{\Delta I_c}{\Delta I_b}$

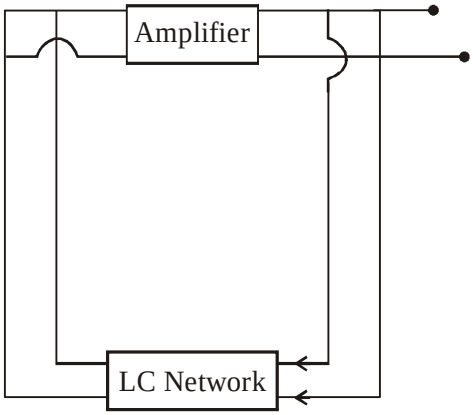
Voltage gain (A_v) = Current gain × Resistance gain = $\beta \times A_v$

Power gain = β^2 × Resistance gain

Resistance gain = $\frac{R_o}{R_i}$

Transistor used as an oscillator converts D.C. into A.C.

Amplifier section is just a transistor used in common-emitter mode.



$$f_0 = \frac{1}{2\pi}\frac{1}{\sqrt{LC}}$$

Part of output energy is sent back in phase to input circuit. This is also called positive feed back.