Class : 12th Physics
Chapter- 14 : Semiconductor Electronics Materials, Devices & Simple Circuits

Semiconductor Electronics Materials, Devices and Simple Circuits

- **Classification of metals, semiconductor & Insulator on the basis of bond theory**
  - **Semiconductors**
    - For- n-type $= 7 \times 10^{15} m^{-3}$ for Si doped with P
      E_g [C.B / V.B]
    - For- p-type $= 1 \times 10^{9} m^{-3}$ for Si doped with Al
    - → very low (e)
    - → $Eg = 0.72$ eV for Ge
      ≈ 1.1ev for Si
      $0 < E_g <$ Insulator
  - **Conductors**
    - → $Eg = 0$ or least
    - → Density of charge carriers is very high (For electrons e)
      $= 9 \times 10^{23} m^{-3}$ for For Hole (h)
      $= 0 m^{-3}$ (in case of copper)
      C.B. / V.B. $E_g = 0$
  - **Insulator**
    - → $Eg =$ very high
      ≈ 7eV for diamond
      → negligible [C.B / $E_g >>$ / V.B]
      ≈ 0
- **Huygen's Principle**
  - **P.N junction Diode** → Device made by a close contact of N-type and P-type semiconductor
  - **Forward Biased** → - +ve terminal to P-side - -ve to N-side - diffusion current increase
  - **Reverse Biased** → - +ve terminal to P-side - +ve terminal to N-side - diffusion current decreases - depletion layer increases
  - **Light Emitting Diode/LED** → Used in T.V. or electronic gadgets
  - **Photo Diode** → is a P.N. junction whose function is controlled by the light allowed to fall on it
  - **Zener Diode** → Used as a voltage regulator
- **Energy Band**
  - **A range of energies associated with the quantum states of electrons in a crystalline solid**
    - **Valence Band** → The energy band which are completely filled with electron at OK
    - **Conduction Band** → The bands with higher energy above the valence band [C.B / V.B]
    - **Band Gap or Forbidden Gap** → The difference between the highest energy in a valence band and lowest energy in the next higher band.
- **Contribution** → In 1972, Walter Heitler and Fritz London discover bands
- **Intrinsic Semiconductor**
  - Pure semiconductor
  - Charge carrier concentration
    $n_i = n_e = n_h$
    $I = n_e + n_h$
    e.g. Si (Silicon)
- **Extrinsic Semiconductor**
  - **Impure or doped semiconductor**
    - **N-Type semiconductor**
      - Si or Ge doped with trivalent (B, Al) element
      - Electrons are minority carriers
      - Holes are majority carriers
    - **P-Type semiconductor**
      - Si or Ge doped with pentavalent (P,As, Sb) element
      - Electrons are majority carriers
      - Holes are minority carriers
- **Transistor**
  - **is a three terminal device**
    - **p-n-p transistor**
      - In normal operation emitter, base junction is always forward biased
        E | base | C
        p | n | p
        p-n-p transistor
    - **n-p-n transistor**
      - $I_E = I_B + I_c$
      - $\alpha = I_c / I_E$
      - $\beta = I_c / I_B$
      - $\beta = \frac{\alpha}{1-\alpha}$
      - E | base | C
        n | p | n
        n-p-n transistor
- **Logic Gates**
  - 1-Or Gate — A, B → Y=A+B
  - 2-AND Gate — A, B → Y=A.B
  - 3- NOT Gate — A → $Y=\overline{A}$
  - 4-NOR Gate — A, B → $Y=\overline{A+B}$
  - 5-NAND Gate — A, B → $Y=\overline{A.B}$

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