Chapter No. 26: Current and Resistance

Magnetism: “Moving charges”

Electrostatics: “Rest charges” → Point charge

Applications:

1. Medical field
   → nerve current

2. Electrical circuits
   → moving charges

3. Space Engineers

Electric Current:

Stream of moving charges

Assumptions

1. Steady Currents
   → (time-independent)

2. Conventional current (+ve)

Mathematical Definition

\[ i = \frac{dq}{dt} \]

\[ q = \int dq = \int i dt = i \int dt = it \]
\[ i = \frac{q}{t} \]

\[ \frac{c}{l} = 1 \quad (A) \]

Scalar Quantity

\[ \equiv \text{flow of charges} \]

\[ i_0 = i_1 + i_2 \quad \text{Conserved} \]
Current Density

Charges Density
\[ \lambda = \frac{dq}{dl} \]
\[ q = \lambda l \]

Intend to study the flow of charges through a cross-section of the conductor.

Surface Current Density \( (J) \)
\[ i = \int J \cdot dA \]
\[ J = \frac{i}{A} \text{ m}^2 \]

Physical Intuition
Streamlines of the current
Drift Speed

\[ E \rightarrow J \rightarrow V_d \]

Assumptions:
1. All charge carriers move with same \( V_d \)
2. Current Density \( J \) is uniform throughout \( A \).

\[ q = \left( \frac{n A L}{\text{e}} \right) e \quad (q = ne) \]

\[ t = \frac{L}{V_d} \quad (s = vt) \]

\[ i = \frac{q}{t} = \frac{n A L e}{V_d} \]

\[ i = n A e V_d \quad \Rightarrow \quad V_d = \frac{i}{n A e} \]

\[ V_d = \frac{J}{ne} \quad \Rightarrow \quad J = \frac{ne V_d}{V_d} \]
a) Current ($i$): Rightward
b) Current Density ($J$): Rightward
c) Electric Field ($E$): Rightward