Lecture-1 Electric current and current density

* **Electric current :** An electric current is a stream of charged particles, such as electrons or ions, moving through an electric conductor or space. It is measured as the net rate of flow of electric charge. SI units - Ampere (A)

$$I = \frac{q}{t}$$

$$I(t) = \lim_{\Delta t \to 0} \frac{\Delta Q}{\Delta t}$$

* **Drift of electrons**

Average velocity of all electrons will be zero since their directions are random.

$$\frac{1}{N} \sum_{i=1}^{N} \vec{V_i} = 0 \qquad \text{where, } N \to \text{no. of } e^-$$
$$\vec{V_i} \to \text{Velocity of } e^-$$

Electrons get accelerated due to electric field

$$\vec{a} = \frac{-e\vec{E}}{m} \qquad \text{where, } \vec{a} \to \text{acceleration}$$
$$e \to \text{Charge}$$
$$\vec{E} \to \text{Electric field}$$
$$m \to \text{mass of } e^-$$

$$\vec{V_i} = \vec{v_i} + \frac{-e\vec{E}}{m} t_i \qquad \vec{v_i} \to \text{Velocity immediately after the last collision}$$
$$\vec{V_i} \to \text{Velocity at time } t$$

$$\vec{V_d} = (\vec{V_i})_{average} = \underset{\underset{0}{\downarrow}}{(\vec{v_i})_{average}} - \frac{e\vec{E}}{m}(t_i)_{average}$$

$$\therefore \vec{V_d} = -\frac{e\vec{E}}{m}(t_i)_{average} \qquad \vec{V_d} \to \text{drift velocity}$$

$$\vec{V_d} = -\frac{e\vec{E}}{m}\tau$$

* $I \Delta t = +ne A |V_d| \Delta t$ where, $I \to$ Current
$$A \to \text{Area}$$

$$I \Delta t = \frac{e^2 A}{m} \tau n \Delta t |E|$$