Magnetostatics Part-4

Stationary charges → Constant electric field
⇒ electrostatics

Steady Currents → Constant magnetic fields
⇒ magnetostatics

↑

Continuous flow that has been going on forever without change and without charge piling up anywhere

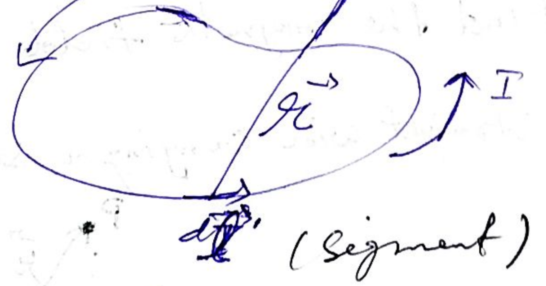
In earlier lecture note we have obtained the continuity equation $\frac{\partial \rho}{\partial t} + \nabla \cdot \vec{J} = 0$ { $\vec{J}$ → volume current density

For steady current $\frac{\partial \rho}{\partial t} = 0$

$$\Rightarrow \boxed{\nabla \cdot \vec{J} = 0} \rightarrow \text{In magnetostatics}$$

Biot-Savart law :—

The magnetic field of a steady line current is given by



$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} \int \frac{\vec{I} \times \hat{\mathscr{r}}}{\mathscr{r}^2} dl' = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{l}' \times \hat{\mathscr{r}}}{\mathscr{r}^2}$$

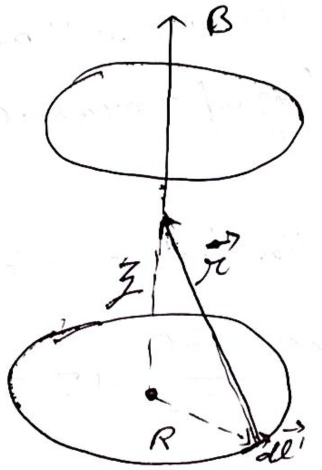
where $\frac{\mu_0}{4\pi} = 10^{-7} \, N/A^2$

$\mu_0 \rightarrow$ Permeability of free space

Unit of $\vec{B} \longrightarrow$ Tesla

$$1\,T = 1\left(\frac{N}{A\,m}\right)$$

Q.1 Find the magnetic field a distance z above the centre of a circular loop of radius R, which carries a steady current I



(Q.2) Find the magnetic field at ~~a centre~~ the centre of a regular n-sided polygon carrying a steady current I. Assume that R be the distance from the centre to any side

(Q.3) Find the magnetic field a distance s from a long straight wire carrying a steady current I