Name - Trupti Sahu

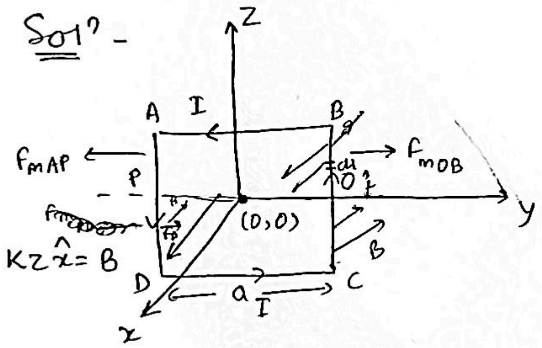
Roll no. - 20221279

Batch = B_6

Date = 11.05.2023

(Q) Suppose that the magnetic field in some region has the form $B = Kz\hat{x}$. (where K is a constant). Find the force on a square loop of side a lying on ~~xy~~ yz plane and centered at the origin, if it carries a current I, flowing counterclockwise when you look down the x axis.

Sol^n -



~~for~~ force ~~due~~ on part AB -

$\Rightarrow F_{m_{AB}} = \int I(\vec{dl} \times \vec{B})$ here $B = K\left(\frac{a}{2}\right)$.

$\Rightarrow F_m = \left(\frac{Ka}{2}\right) \times aI = \frac{Ka^2 I}{2}\hat{K}$.

~~force~~ force on OB -

$$F_{m_{OB}} = \int I(\vec{dl} \times \vec{B}) = \int_0^{a/2} I \times (dl \times K l) = \frac{Ka^2}{4}\hat{j}.$$

On OC -

$$F_{m_{OC}} = -\frac{Ka^2}{4}\hat{j}.$$

Similarly force on PD - $F_{m_{PD}} = \frac{Ka^2}{4}\hat{j}$

on AP = $F_{m_{AP}} = -\frac{Ka^2}{4}\hat{j}$

and force on CD -

$$F_{m_{CD}} = \int I(\vec{dl} \times \vec{B}) = \left(\frac{Ka}{2}\right) \times aI = \frac{Ka^2 I}{2}\hat{K}.$$

$\Rightarrow$ Total force on loop will be -

$$\vec{F}_{Tot} = \vec{F}_{m_{AB}} + \cancel{\vec{F}_{m_{OB}}} + \cancel{\vec{F}_{m_{OC}}} + \cancel{\vec{F}_{m_{PD}}} + \cancel{\vec{F}_{m_{AP}}} + \vec{F}_{m_{CD}} = \frac{Ka^2 I}{2}\hat{K} + \frac{Ka^2 I}{2}\hat{K}$$

$$= Ka^2 I\hat{K}.$$

$\Rightarrow \boxed{F_{Tot} = Ka^2 I\hat{k}}$