Magnetostatics Questions

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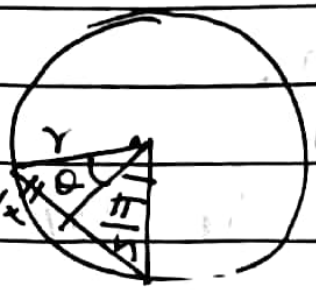
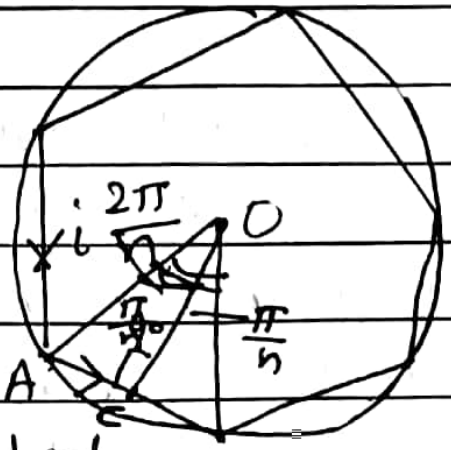
Q:1 A current I flows along thin wire shaped as a regular polygon with n side which can be inscribed into circle of radius R. Find the magnetic induction at centre of polygon. Analyse the obtain expression for $n \to \infty$

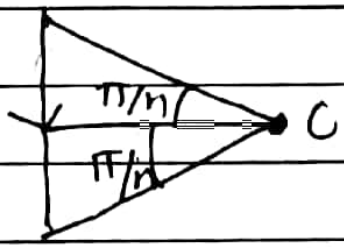
Solution:





We knows the circle mpart 2π angle and having n side the angle will be $\frac{2\pi}{n}$, and the fig is just like that

Then applying Biot savart law



From the formula.

$$B = \frac{\mu_0 I}{4\pi R}\left[\sin\alpha + \sin\beta\right]$$

$$OC = R\cos\frac{\pi}{n}$$

$$\alpha = \beta = \pi/n$$

$$R = OC$$

$$= R\cos\frac{\pi}{n}$$

$$B = \frac{\mu_0 I}{4\pi R\cos\frac{\pi}{n}} \times 2\sin\pi/n$$

The Total calculation can be found we can take small component

$$dB = \int \frac{\mu_0 i\, dx}{4\pi r^2} \cos\theta$$

$$= \int_{-\pi/n}^{+\pi/n} \frac{\mu_0 i\, R \cos\frac{\pi}{n} \sec^2\theta\, d\theta}{4\pi \; R^2 \cos^2\frac{\pi}{n} \sec^2\theta}$$

$x = r \tan\theta$

$dx = r \sec^2\theta\, d\theta$

$$B = \frac{\mu_0 i}{4\pi} \frac{2 \sin\pi/n}{R \cos\pi/n}$$

if there are n side the magnetic Induction will be nB

$$B_0 = \frac{\mu_0 ni}{4\pi} \frac{2\sin\pi/n \; n}{R\cos\pi/n}$$

$$= \frac{\mu_0 ni}{2\pi R} \frac{\tan\pi}{n} \quad \text{and for}$$

$n \to \infty$

$$B_0 = \frac{\mu_0 i}{2R} \lim_{n\to\infty} \left(\frac{\tan\pi/n}{\pi/n}\right)$$

$$B_0 = \frac{\mu_0 i}{2R} \qquad \frac{1}{1}$$

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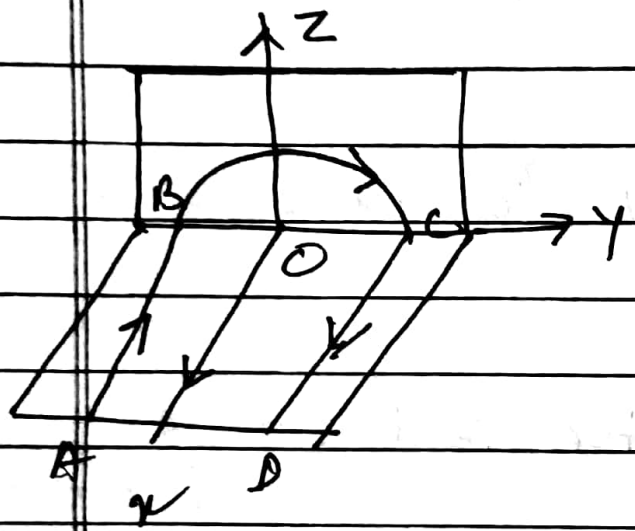
Question 2. Find the magnetic induction at the point O. if the wire carrying a current $I = 8$ A has shape



Solution := at O the magnetic induction will be

$$B_0 = B_1 + B_2 + B_3$$

straight wire AB	semicircle BC	CD straight wire

$$= \frac{\mu_0 i}{4\pi R}(-k) + \frac{\mu_0 \times \pi}{4\pi R}(-i) + \frac{\mu_0 i}{4\pi R}(-k)$$

$$= -\frac{\mu_0 i}{4\pi R}\left[2k + \pi i\right]$$