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Module	4^{th}
Subject	Electro Magnetic Field
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Q No 1 :-

Determine The magnatic field at The center-----

Ans:-

The radius of The of piece of wire = 0.20 m

current carried by The semicular pice of wire = 150 A

magantic filed is give as $B = \frac{\mu_0 N I}{2a}$

The different form of Boit-severt Law is given as

$$dB = \frac{\mu_0 I}{4\pi} \frac{dI \sin\theta}{r^2}$$

$$B = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{I} \times \hat{r}}{r^2} = \frac{\mu_0}{4\pi} \frac{1}{r^2} \int dI$$

$$= \frac{\mu_0}{4\pi} \frac{I}{r^2} \pi r = \frac{\mu_0 I}{4r} = \frac{4\pi \times 10^{-7} \, Tm/A \, (150 A)}{4(0.20 m)}$$

$$= \boxed{2.4 \times 10^{-4} T} \rightarrow \text{Ans.}$$

Q No 2 :— Part (b)

= A circular coil of radius $5 \times 10^{-2} m$ and with 40 - - - - - -

Ans :

The radius of the circuil coil = $5 \times 10^{-2} m$

number of turns of the circular coil = 40

current carried by the circular coil = 0.25 A

magnatic field is given as.

$$B = \frac{\mu_0 n I}{2a}$$

$$= \frac{4\pi \times 10^{-7} Tm/A (40) 0.25 A}{2 \times 5.0 \times 10^{-2} m}$$

$$\boxed{= 1.2 \times 10^{-4} T}$$ → Ans

Q no 2:—

part (a)

compute The magnetic field of a long straight wire That has a circular loop with ......

ANS:—

Given data

Radius $= r = 0.05\,m$

$I = 2\,amp$

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

Ampere's law formula is

$$\oint \vec{B}\, d\vec{l} = \mu_0 I$$

In The case of long straight wire

$$\oint d\vec{l} = 2\pi R = 2 \times 3.14 \times 0.05 = 0.314$$

$$B \oint d\vec{l} = \mu_0 I \Rightarrow \vec{B} = \frac{\mu_0 I}{2\pi R}$$

$$\vec{B} = \frac{4\pi \times 10^{-7} \times 2}{0.314} = \boxed{8 \times 10^{-6}\, T}$$

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Q No 2 :—

(part b)

within The cylinder $\rho = 2$ $0 < z < 1$ The potential is given by $V = 100 + 50\rho + 150\rho \sin\phi V$ -----

Ans :—

(a)

$$E = -\nabla V = \frac{\partial V}{\partial \rho} a_\rho - \frac{1}{\rho}\frac{\partial V}{\partial \phi} a_\phi$$

$$= -[50 + 150 \sin\phi] a_\rho - [150 \cos\phi] a_\phi$$

Evalute The above at ρ to find E_ρ

$$E_\rho = -179.9 a_\rho - 75.0 a_\phi \text{ V/m}$$

Now $D = \epsilon_0 E$, so D_ρ

$$D_\rho = -1.59 a_\rho - .664 a_\phi \text{ nC/m}^2$$

Then

$$\rho_v = \nabla \cdot D = \left(\frac{1}{\rho}\right) \frac{d}{d\rho}(\rho D_\rho) + \frac{1}{\rho} \frac{\partial D_\phi}{\partial \phi}$$

$$= \left[-\frac{1}{\rho}(50 + 150 \sin\phi + \frac{1}{\rho} 150 \sin\phi\right] \varepsilon_0$$

$$= -\frac{50}{\rho} \varepsilon_0 C$$

At P, This is $\rho_v P = -443 \ \mathrm{Pc/m^3}$

(b) How much charge lies withine The cylinder?

we will intergract ρ_v over The volume to obtain.

$$Q = \int_0^1 \int_0^{2\pi} \int_0^2 -\frac{50 \varepsilon_0}{\rho} \rho d\rho d\phi dz$$

$$= 2\pi(50)\varepsilon_0 (2) = \boxed{-5.56 nC}$$

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Q No 3 :-

Given The time-varying magnetic field $B = (0.5 a_x + 0.6 a_{xy} - 0.8 a_z) \cos 5000 t$ ---------

solution :-

$$emf = \oint E \cdot dL = -\frac{d\phi}{dt} \Rightarrow$$

$$= -\frac{d}{dt} \iint_{loop\,area} B \cdot a_z \, da = \frac{d}{dt} (0.3)(4)(6) \cos 5000 t$$

where The loop normal is chosen as positive a_z, so That The path integral for E is taken around The positive a_ϕ direction. Taking The derivative we find

$emf = -7.2 (5000) \sin 5000 t$ so That

$$I = \frac{emf}{R} = \frac{-36000 \sin 5000 t}{400 \times 10^3}$$

$$\boxed{= -90 \sin 5000 t \ mA} \Rightarrow Ans.$$