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Module : 4Th Sem.

Q No. 1 part (a)

Ans:-

Given:-

radius = r = 0.2 m
Current = I = 150 A

Required:-

Magnetic field = B = ?

Solution:-

As we know

$$B = \frac{\mu_0 I}{2\pi r}$$

$$= \frac{(4\pi \times 10^{-7}\ T.m/A)(150\ A)}{2(3.14)(0.2\ m)}$$

$$= \frac{4\pi(150)}{2\pi(0.2)} \times 10^{-7}\ T$$

$$= 2(750) \times 10^{-7}\ T$$

$$B = 1500 \times 10^{-7}\ T$$

$$B = 150 \times 10^{-6}\ T$$

$$\boxed{B = 150\ \mu T}$$

Q No. 1 Part b

Ans

Given:-

radius = 5×10^{-2} m
No. of turn = N = 40 turns

current = I = 0.25 A

Req :-

$B = ?$

Sol :-

As we know

$$B = \frac{\mu I N}{L}$$

$$= \frac{(4\pi \times 10^{-7}\ T \cdot m/A)(0.25\ A)(40)}{5 \times 10^{-2}\ m}$$

$$= \frac{(12.56)(0.25)(40)}{5 \times 10^{-2}} \times 10^{-7}\ T$$

$$= \frac{125.6}{5 \times 10^{-2}} \times 10^{-7}\ T$$

$$= \frac{125.6}{5} \times 10^{-5}\ T$$

$$= 25.12 \times 10^{-5}\ T$$

$B = 251\ \mu T$

Q No. 2 part (a)

Ans

Given :-

radius = 0.05 m

current = I = 2 A

Req :-

$B = ?$

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Solution :-

$$B = \frac{\mu_o I}{2\pi r}$$

$$= \frac{(4\pi \times 10^{-7}\ T.m/A)(2\ A)}{2\pi (0.05\ m)}$$

$$= \frac{(4\pi)(2)}{2\pi(0.05)} \times 10^{-7}\ T$$

$$= \frac{8\pi}{2\pi (0.05)} \times 10^{-7}\ T$$

$$= \frac{4}{0.05} \times 10^{-7}\ T$$

$$B = 80 \times 10^{-7}\ T$$

$$\boxed{B = 800\ \mu T}$$

Q No. 4 part (b)
Ans

Given :-

$$V = 100 + 50\rho + 150\rho \sin\phi\ V$$
$$P_V = P(1, 60°, 0.5)$$

Sol :-

As

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

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

Evaluate the above at 'p' to find

E_p =

$-179.9 a_\rho - 75.0 a_\phi$ V/m

Now

$D = \epsilon_0 E$, so $D_p = -1.59 a_\rho - .664 a_\phi$ nC/m²

then

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

$\left[-\frac{1}{\rho}(50 + 150 \sin\phi) + \frac{1}{\rho} 150 \sin\phi \right] \epsilon_0$

$= -\frac{50}{\rho} \epsilon_0 C$

At P, this is $\rho_v P = -443$ pC/m³

(b)

$Q = \int_0^1 \int_0^{2\pi} \int_0^2 -\frac{50 \epsilon_0}{\rho} \rho \, d\rho \, d\phi \, dz =$

$-2\pi (50) \epsilon_0 (2) = -5.56$ nC

$$\boxed{Q = -5.56 \text{ nC}}$$

Q No. 3

Ans

Given :-

$B = (0.5 a_x + 0.6 a_y - 0.3 a_z)$

Solution :-

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

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

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 derivative we find.

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

so that

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

$$\boxed{emf = -90 \sin 5000t \text{ mA}}$$