Course Title :-
Electro magnetic
Field theory.

Module :- 4th Semester

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Question No 2:-

(a) Part.

ompute/ Determine the magnetic field af ~~the~~ ~~center~~ a Long Straight wire that has a circular Loop with a radius of 0.05 m. 2amp is the reading of the current flowing through this closed Loop?

Solution:-

⇒ Given Data:-

$R = 0.05m$

$I = 2amp$

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

Ampere's Law formula is

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

In the case of Long straight wire.

2

$$\oint \vec{dl} = \mu_0 I$$

$$\vec{B} = \frac{\mu_0 I}{2\pi R}$$

$$\vec{B} = \frac{4\pi \times 10^{-7} \times 2}{0.314}$$

$$= 8 \times 10^{-6}\ T$$

Question No 1
Part (b) :-

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

Number of turns of the circular coil $= 40$

Current carried by the circular coil $= 0.25A$

Magnetic field is given as: $B = \frac{\mu_0 N I}{2a}$

$$= \frac{4\pi \times 10^{-7} T\cdot m/A\,(40)\,0.25A}{2.50 \times 10^{-2} m}$$

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

Question No 1

Part (a)

Answer:-

The radius of the semicircular piece of wire $= 0.20m$.

Current carried by the semicircular piece of wire $= 150A$

Magnetic field given as: $B = \frac{\mu_0 N I}{2a}$

The differential form of Biot-Savart Law is given as:

$dB = \frac{\mu_0 I}{4\pi} \frac{dl \sin\theta}{r^2}$ since $B = \frac{\mu_0}{4\pi} I \int \frac{dI \times \hat{r}}{r^2}$

$$= \frac{\mu_0}{4\pi} \frac{I}{r^2} \int dI = \frac{\mu_0}{4\pi} \frac{I}{r^2} \pi = \frac{\mu_0 I}{4r} = \frac{4\pi \times 10^{-7} T\cdot m/A}{4(0.20m)}$$

$$= 2.4 \times 10^{-4} T.$$

Question No 3:-

Answer:-

$$emf \oint E \cdot dL = -\frac{d\Phi}{dt} = -\frac{d}{dt}\int_{loop\,area} B \cdot a_z\, da = \frac{d}{dt}(0.3)(4)(6)\cos 5000t.$$

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.

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

$$I = \frac{emf}{R} = \frac{-36000 \sin 5000t}{400 \times 10^3} = -90 \sin 5000t \, mA$$

(5)

Question No 2 :-
part (b):

(a) Find V, E, D, and ρ_v at P(1, 60°, 0.5) in free space: First, substituting the given point, we find.

$V_P = 279.9V$. Then

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

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

Evaluate the above at P to find E_P

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

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

$$\rho_v = \nabla \cdot D = \left(\frac{1}{\rho}\right)\frac{d}{d\rho}(\rho D_\rho) + \frac{1}{\rho}\frac{dD_\phi}{\rho\, d\phi} = \left[\frac{1}{\rho}(50 + 150 \sin\phi) + \frac{1}{\rho} 150 \sin\right.$$

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

At P, this is $\rho_{vP} = -443$ pC/m³.