

Course Title :-

Electro magnetic
field theory.

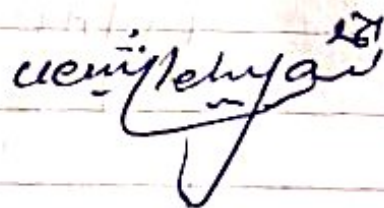
Module :- 4th Semester

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Question No 2:-

(a) Part:

Compute/ Determine the magnetic field at the center of a long straight wire that has a circular loop with a radius of 0.05m . A amp is the reading of the current flowing through this closed loop?

Solution:-

⇒ Given Data:-

$$R = 0.05\text{m}$$

$$I = 2\text{amp}$$

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

Ampere's Law Formula is

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

In the case of long straight wire.

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

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

$$\begin{aligned}\vec{B} &= \frac{4\pi \times 10^{-7} \times 2}{0.314} \\ &= 8 \times 10^{-6} \text{ T}\end{aligned}$$

Question No 1

Part (b) :-

Answer:

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

Number of turns of the circular coil = 40

Current carried by the circular coil = 0.25 A

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

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

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

Question No 1

Part (a)

Answer:-

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

Current carried by the semicircular piece of wire = 150 A

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

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

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

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

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

(4)

Question No 3:-

Answer:-

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

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:

$$\text{emf} = -7.2 (5000) \sin 5000t \text{ so that}$$
$$I = \frac{\text{emf}}{R} = \frac{-36000 \sin 5000t}{400 \times 10^3} = -90 \sin 5000t \text{ mA}$$

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Question No 2:-
part (b):

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

$$V_p = 279.9 \text{ V. Then}$$

$$E = -\nabla V = -\frac{dV}{dp} a_p - \frac{1}{P} \frac{dV}{d\phi} a_\phi$$

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

Evaluate the above at P to find E_p

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

$$\text{Now } D = \epsilon_0 E, \text{ so } D_p = -1.59 a_p - 664 a_\phi \text{ nC/m}^2$$

$$\rho_v = \nabla \cdot D = \left(\frac{1}{P}\right) \frac{d}{dP} (P D_p) + \frac{1}{P} \frac{dD_\phi}{d\phi} = \left[\frac{1}{P} (50 + 150 \sin \phi) + \frac{1}{P} 150 \cos \phi\right]$$

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

At P , this is $\rho_{vP} = -443 \text{ pC/m}^2$.