-: COURSE DETAILS :-

Course Tittle :- EMF

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-: STUDENT DETAILS :-

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Q NO. One :-

(A) :- Determine the magnetic field at the center of the semi-circular piece of wire with radius 0.20 m - The current carried by the semi-circular of wire is 150 A-

Solution:-

The radius of the semicircular piece of wire = 0.20 m

Current carried by the semicircular piece of wire = 150 A

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

The differential form of Biot-Savart law is given as : $dB = \frac{\mu_0 I}{4\pi} \frac{dI \sin\theta}{r^2}$, $B = \frac{\mu_0 I}{4\pi} \int \frac{dI \times \hat{r}}{r^2}$

$$\Rightarrow B = \frac{\mu_0}{4\pi} \frac{I}{r^2} \int dI$$

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

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

QNO. (One) Part (B)

(B) A circular coil of radius 5×10^{-2} m and with 40 turns is carrying a current of 0.25 A. Determine the magnetic field of the circular coil at the center.

Solution:-

The radius of the circular coil $= 5\times10^{-2}m$

Number of turns of the circular coil $= 40$

Current carried by the circular coil $= 0.25A$

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

$$B = \frac{4\pi\times10^{-7}\,T\cdot m/A(40)0.25A}{2.50\times10^{-2}m}$$

$$\boxed{B = 1.2\times10^{-4}\,T}$$

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Q NO.(Two) part (A)

(A):-

Compute the magnetic field of a long straight wire that has a circular loop with a radius of 0.05m - 2amp is the reading of the current flowing through this closed loop-

Solution:-

Given data:-

$Radius = r = 0.05m$

$I = 2amp$

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

Ampere's law formula is

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

In the case of long straight wire

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

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

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

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

QNO. (TWO) part (B) :-

(B) :-

Within the cylinder $\rho = 2$, $0 < z < 1$, the potential is given by $V = 100 + 500\rho + 150\rho \sin\phi$ V

(a):- Find V, E, D and ρ_v at $P(1, 60°, 0.5)$ in free space -

(B):- How much charge ~~[illegible]~~ lies within the cylinder?

Solution:- (A):- First, substituting the given point we find $V_P = 27\cancel{9}.9$ V. Then:-

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

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

Evaluate the above at P to find E_P.

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

Now $D = \epsilon_0 E$, so $D_P = -1.59 a_\rho - (0.664) a_\phi$ nC/m².

Then

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

$$\rho_v = \left[-\frac{1}{\rho}(50 + 150 \sin\phi + \frac{1}{\rho} 150 \sin\phi\right] \epsilon_0 = \frac{50}{\rho} \epsilon_0 C.$$

At P, this is $\boxed{\rho_{vP} = -443 \text{ pC/m}^3.}$

Q No. Two (B) part (B)

(B)

How much charge lies within the cylinder?

Solution:-

We will integrate P_v over the volume to obtain:-

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

$$Q = -2\pi(50)\,\varepsilon_0(2) = -5.56\,nC.$$

Q No. Three (a):-

(A):- Given the time-varying magnetic field $B = (0.5a_x + 0.6a_y - 0.3a_z)\cos 5000t$ T and a square filamentary loop with its cornes at $(2,3,0)$, $(2,-3,0)$ and $(-2,-3,0)$, find the time-varying current flowing in the general a_ϕ direction if the total loop resistance is $400\,k\Omega$.

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

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

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 $I = \frac{emf}{R}$

$$I = -90\sin 5000t\ mA.$$