<u>Department of Electrical Engineering</u>

Course Title: Electro Magnetic Field Theory

Module: 4th semester

<u>Student Detail</u>

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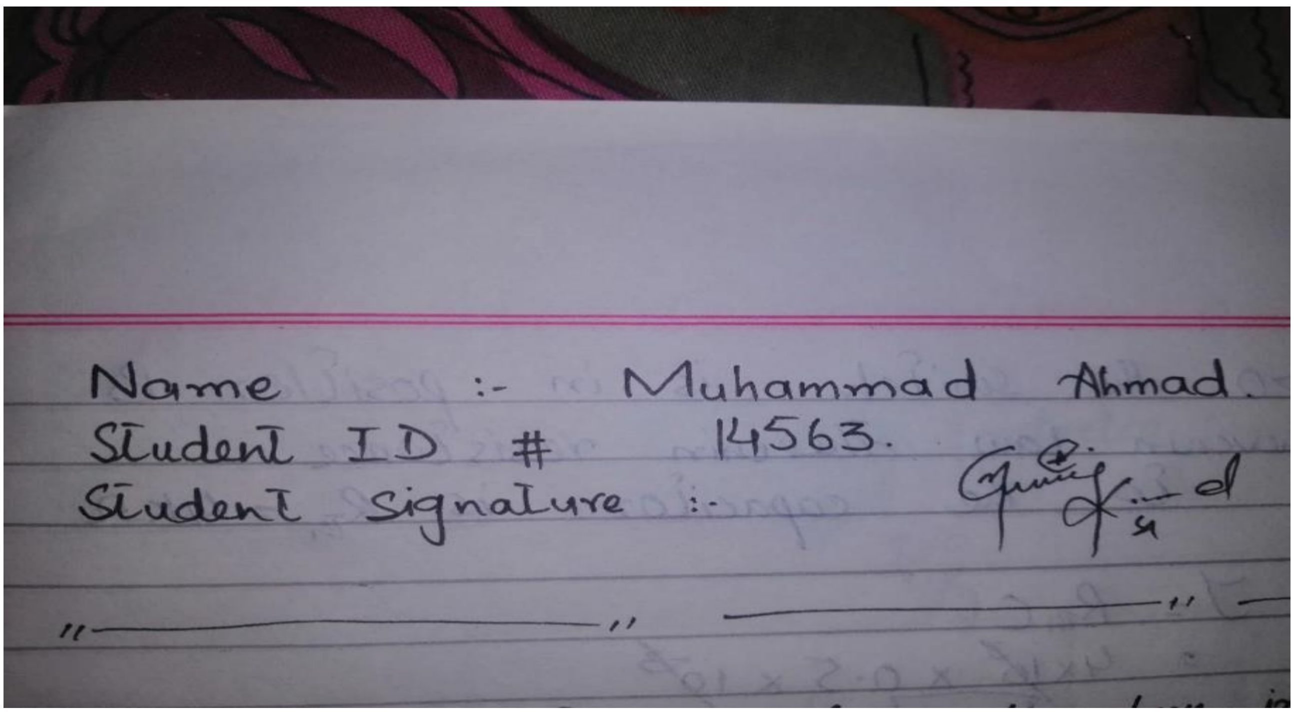

QNo1(a):- Determine the magnetic field at the center of the semi ~~conductor~~ circular piece of wire with radius 0.20m. The current carried by the semicircular of wire is 150A.

Ans Solution:-

The radius of the semicircular piece of wire = 0.20m

current carried by the semicircular piece of wire = 150A.

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

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

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

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

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

$$= \frac{\mu_0}{4\pi} \frac{I}{r^2} \pi r$$

$$= \frac{\mu_0 I}{4r}.$$

$$= \frac{4\pi \times 10^{-7} \, T.m/A(150)}{4(0.20m)}$$

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

"——————"——————"

QNo1 (b) A circular coil of radius $5 \times 10^{-2}\,m$ and with 40 turns is carrying a current of 0.25A. Determine the magnetic field of the circular coil at the center.

Ans:- Solution:-

The radius of the circular coil $= 5 \times 10^{-2}\,m$.
Number of turns of the circular coil $= 40$
Current (I) carrying by coil $= 0.25$ Amp.

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

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

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

"——————"——————"

QNo 2 (a)

Given:-

$R = 0.05\,m$
$I = 2$ Amp.
$\mu_0 = 4\pi \times 10^{-7}\,N/A^2$

Ampere's Law Formula.

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

In the case of long straight wire

$$\oint d\vec{l} = 2\pi R$$

$$= 2 \times 3.14 \times 0.05$$

$$= 0.314$$

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

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

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

$$= \frac{4 \times 3.14 \times 10^{-7} \times 2}{0.314}$$

$$\boxed{\vec{B} = 8 \times 10^{-6}\, T}$$ Ans.

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QNo 2 (b)

(A) Find $V, E, D,$ & ρ_v at $P(1, 60^\circ, 0.5)$

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

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

Evaluate the above at P to find E_P

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

Now $D = \varepsilon_0 E$

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

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

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

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

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

(b) How much charge lies within the cylinder?

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

$$= -2\pi(50)\varepsilon_0(2)$$

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

Q No 3:-

$$emf = \oint E \cdot dL$$

$$-\frac{d\bar{\Phi}}{dt} = \frac{d}{dt}\iint_{loop\,area} B \cdot a_z \, da$$

$$= \frac{d}{dt}(0.3)(4)(6)\cos 5000t.$$

where the loop is 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

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

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

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