Course Details

Course Tittle	E-M-F
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Module	4th

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Q1 (9) Determine the megnatic field
- - - - - - - - . The current
Carried by the semicircular of
wire is 150A.

The radius of the semicircular
Piece of wire = 0.20m
Current carried by the semicircular
Piece of wire = 150 A

Magnetic field is given as:

$$B = \frac{\mu_0 NI}{2a}$$

The differential form of Biot- savart
law is given by:

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

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

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

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

Q1 (b) A circular coil of radius $5 \times 10^{-2} m$ - - - - - - - - . Determine the magnetic field of circular coil at the center.

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 = 0.25 A

Magnetic field is given as:

$$B = \frac{\mu_0 N I}{2a}$$

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

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

Q3 (a) Compute the magnetic field - - - -
- - - - - - current flowing through
this closed loop.

Given

$R = 0.05m$

$I = 2 amp$

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

Ampere law formula is

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

In the case of long straight wire

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

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

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

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

$$\Rightarrow \boxed{8 \times 10^{-6} \, T}$$

Q2 With in the clyinder $\rho = 2, 0 < z < 1$ the

(b) - - - - - - - (a) - - - - -

(b) How much charge lies within the clyinder ?

(A) First substituting the given point, we find $V_p = 279.9\,V$. Then

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

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

Evaluate the above at P to find

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

Now $D = \varepsilon_0 E$ so $D_p = -1.59 a_\rho - .664 a_\phi \ nC/m^2$

Then

$$\rho_v = \nabla \cdot D = \left(\frac{1}{\rho}\right)\frac{d}{d\rho}(\rho D_\rho) + \frac{1}{\rho}\frac{\partial D_\phi}{\partial \phi} = \left[-\frac{1}{\rho}(50 + 150\phi) + \frac{1}{\rho} 150 \sin\phi\right]\varepsilon_0$$

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

At P, this is $\rho_v P = -443\ pC/m^3$

(B) We will integrate ρ_v over the volume to obtain:

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

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

Q3 (a) Given the time-varying magnetic field $B = (0.5a_x + 0.6a_y - 0.3a_z)$ - - - - - - - - - - total loop resistance is $400\ k\Omega$

We write:

$$emf = \oint E \cdot dl = -\frac{d\phi}{dt} = -\frac{d}{dt}\iint_{\text{loop area}} B \cdot a_z \, da ,$$

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

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

$emf = -7.2(5000)\sin 5000t$ so that $I = \frac{emf}{R}$

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