

Date: _____

(1)

Question 1 (a)

Ans) Radius of wire = 0.20m

Current carried by it = 150A

As we know magnetic field is given as:

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

Differential form of Biot-Stavart Law

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

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

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

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

x ——— x ——— x

Question 1 (b)

Ans)

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

No turns of circular coil = 40

Current carried by circular coil = 0.25A

Date: _____

(2)

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

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

$$2.50 \times 10^{-2} \text{ m}$$

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

x ——— x ——— x

Question 2 (a)

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

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

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

Using Ampere law formula

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

In the case of long straight wire

$$\oint \vec{B} \cdot d\vec{l} = 2\pi R = 2 \times 3.14 \times 0.05$$
$$= 0.314$$

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

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

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

Date: _____

(3)

Question 2 (b)

a) Substituting the given point, we find

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

$$E = -\nabla V = -\frac{\partial V}{\partial \rho} a_\rho - \frac{1}{\rho} \frac{\partial V}{\partial \phi} a_\phi = -[50 + 150 \sin \phi] a_\rho - [150 \cos \phi] a_\phi$$

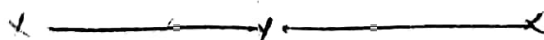
Evaluate the above at P to find $E_p = -179.9 a_\rho - 75.0 a_\phi$
 $-75.0 a_\phi \text{ V/m}$

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

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

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

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



Date: _____

(4)

Question 3 (a)

Ans)

$$\text{emf} = \oint \mathbf{E} \cdot d\mathbf{L} = \frac{d\Phi}{dt} = - \frac{d}{dt} \int_{\text{loop area}} \mathbf{B} \cdot \mathbf{a}_z dq = \frac{d(0.3)(4)(6)}{dt} \times \cos 5000t$$

Where loop normal is chosen as +ive \mathbf{a}_z . So integral for \mathbf{E} is taken around the +ive \mathbf{a}_ϕ direction.

Taking the derivative, we find.

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

$$= -90 \sin 5000t \text{ mA}$$

* ——— * ——— *