Date: _____

Question 1 (a)

Ans) Radius of wire = 0.20m

Current carried by it = 150A

As we know magnetic field is given as:

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

Differential form of Biot-Stavart Law

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

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

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

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

x ——— x ——— x

Question 1 (b)

Ans)

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

No turns of circular coil = 40

Current carried by circular coil = 0.25A

Date:_____ (2)

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

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

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

x ——— x ——— x

Question 2 (a)

Ans) $R = 0.05 m$

$I = 2 amp$

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

Using Ampere law formula

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

In the case of long straight wire

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

$= 0.314$

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

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

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

Question 2 (b)

a) Substituting the given point, we find $V_P = 279.9\,V$. Thus

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

Evaluate the above at P to find $E_P = -179.9a_\rho - 75.0a_\phi - 75.0a_\phi\ V/m$

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

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

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

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

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Question 3 (a)

Ans)

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

Where loop normal is chosen as +ive a_z, So Integral for E is taken around the +ive a_ϕ direction.

Taking the derivative, we find.

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

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

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