Department of Electrical Engineering
Final Assignment
Date: 23-06-2020

Course Details

Course Title: **Electro Magnetic Field Theory** **Module:** **6th**

Instructor: **Dr Rafiq Mansoor.** **Total Marks:** **50**

Student Details

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Q1: Solve the following short Question	**(a)**	Determine the magnetic field at the center of the semicircular piece of wire with radius 0.20m. The current carried by the semicircular of wire is 150A.	**Marks 10** **CLO 2**
	(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.	**Marks 10** **CLO 2**
Q2:	**(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.	**Marks 07** **CLO 2**
	(b)	Within the cylinder ρ =2, 0< z <1, the potential is given by V = 100+50ρ+150ρ $Sin\phi$ V. (a) Find $V, E, D,$ and at p (1, , 0.5) in free space. (b) How much charge lies within the cylinder?	**Marks 08** **CLO 2**
Q3:	**(a)**	Given the time-varying magnetic field B= (0.5 +0.6 – 0.3) and a square filamentary loop with its corners at (2, 3, 0), (2,-3,0), and (-2,3,0) and (-2,-3,0), find the time-varying current flowing in the general direction if the total loop resistance is .	**Marks 15** **CLO 3**

Q(1) (a)

Sol:- 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:

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

The differential from of Biot-Savart law is given as: $dB = \frac{\mu_0 I}{4\pi} \frac{dl \sin\theta}{r^2}$

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

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

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

Q(1) (b)

<u>Sol</u>:- The radius of the circular coil $= 5\times 10^{-2} m$

Number of turns of the circular coil = 40 turns

Current carried by the circular coil = 0.25 A

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

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

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

Q(2) (a)

Sol:-

Given= $R = 0.05m$

$I = 2 amp$

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

Ampere's law formula is

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

In this case of long straight wire

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

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

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

$$\vec{B} = 8 \times 10^{-6} T$$

Q(2) (b)

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

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

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

Then,

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

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

$$\epsilon_0 = -\frac{50}{\rho}\epsilon_0 \, C$$

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

(b) How much charge lies within the cylinder? we will integrate ρ_v over the volume to obtain:

$$Q = \int_0^1 \int_0^{2\pi} \int_0^2 -\frac{50\epsilon_0}{\rho}\rho \, d\rho \, d\phi \, dz =$$

$$-5.56 \, nC$$

Q3: (a)

Sol:- we write

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

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 then

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

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