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

Course Details

Course Title: **Electro Magnetic Field Theory** **Module:** **4th Semester**

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**

Question No: 1 (a).

Determine the magnetic field at the center of semicircular piece of wire with radius 0.20m. The current carried by the semicircular of wire is 150A

Given:

-> The radius of the semicircular piece of wire
= 0.20 m

-> Current carried by the semicircular piece of wire
= 150

Solution:

As
Magnetic field is given as

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

The differential form of Bart-Savart law is given as ;

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

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

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

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

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

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

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

Question No: 1 (b)

A circular coil of radius 5×10^{-2} m El with 40 turns is carrying a current of 0.25A. Determine the magnetic field of the circular coil at the center.

Solution:

⇒ Radius of the circular coil = 5×10^{-2} m

⇒ Number of turns of the circular coil = 40

⇒ Current carried by the circular coil = 0.25A

⇒ Magnetic field is given as:

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

putting the values.

We get,

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

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

Question No: 2 (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.

Given:

Radius = 0.05m
Current = 2 amp
$\mu_0 = 4\pi \times 10^{-7}$ N/A^2

formula:

Ampere's law formula is;

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

Solution:

In the case of long straight wire.

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

putting the values

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

$$\int \vec{dl} = 0.314$$

Now

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

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

putting the values

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

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

Question No: 2 (b)

Within the cylinder $\rho = 2, 0 < z < 1$, The potential is given by $V = 100 + 50\rho + 150\rho \sin\phi$ V.

(a) Find V, E, D & ρ_v at $P(1, 60°, 0.5)$ in free space.

(b) How much charge lies within the cylinder.

For "A":

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

Now $D = \epsilon_0 E$, ~~so D_P~~

So,

$D_P = -1.59a_\rho - 0.664a_\phi$ nC/m².

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/m³

For "B":

We will integrate ρ_v over the volume to obtain.

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

$$= -2\pi\,(50)\,\epsilon_0\,(2)$$

$$= -5.56\,nC$$

Question No: 3

Given the time varying magnetic field $B = (0.5a_x + 0.6a_y - 0.3a_z)\cos 5000t$ T. and a square filmenatary 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 a_ϕ direction if the total loop resistance is 400 kΩ.

Solution:

$$emf = \oint E \cdot dL = -\frac{d\Phi}{dt} \int\int_{loop\ area}$$

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

where the loop ~~ma~~ normal is chosen as positive az. so that the path integral for E is taken around the positive aϕ direction. Taking the derivative, we find.

$$emf = -7.2(5000)\sin 5000t$$

so that,

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

putting the values

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

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