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

Course Detail

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

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

Student Details

Name: Saad Bin Tariq **Student ID:** 5534

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**

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ID: 5534
Department: BE(E)
Subject: Electromagnetic Field Theory
Teacher : Sir Dr Rafiq Mansoor

SAAD BIN TARIQ ID: 5534 Pg# No 1

QNo1 Solve the following Short Questions:-

PART A:-

Determine the magnetic field at the center of the semicircular piece of wire with radius 0.2m. The current carried by the semicircular of wire is 150 A.

ANSWER:-

The radius of the semicircular piece of wire = 0.2m

Current carried by semicircular piece of wire = 150 A

Magnetic field is given as

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

The difference between Biot-Savart Law is given by

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

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

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

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

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

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

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

Q No 1 PART B:-

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

ANSWER:-

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 = 0.25A

Magnetic field is given by

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

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

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

QNO2 PART 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 loop.

ANSWER:-

GIVEN DATA:-

Radius = $R = 0.05m$

$I = 2amp$

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

Amperes law formula is

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

In this case of long straight wire.

$$\oint \vec{dl} = 2\pi R$$

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

$= 0.314$

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

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

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

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

Q No 2 PART "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 and ρ_v at $P(1, 60°, 0.5)$ in free space. (b) How much charge lies within the cylinder.

Part (a):-

$$E = -\nabla V$$

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

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

Evaluate the above P to find E_P

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

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

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

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

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

Part (b)

How much charge lies within the cylinder?

We will ~~obtained~~ integrate ρ_v over the volume to obtain:

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

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

$$= -5.56 \ nC$$

Q No 3

Given the time varing magnetic field $B = (0.5a_x + 0.6a_y - 0.3a_z)\cos 5000t$ T and a square filamentary loop with its corners at (2, 3, 0), (2, -3, 0), and (-2, 3, 0) ~~and (2,~~ find the time varying current flowing in the general a_ϕ direction if the total loop resistance is 4000 kΩ

Solution:-

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

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

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 the derative, we find.

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

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

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