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

Course Details

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

Instructor: ____________ **Total Marks:** 50

Student Details

Name: ____________ **Student ID:** ____________

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 ρ_v at p (1, 60°, 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= $(0.5a_x + 0.6a_y - 0.3a_z)\ cos5000t\ T$ 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 a_φ direction if the total loop resistance is $400k\Omega$.	**Marks 15** **CLO 3**

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Course Title: Electro Magnetic field theory Module: 4th

Department: Electrical Engineering Date: 23/06/2020

instructor:

QNo1 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.

Ans:- The radius of the semicircular piece of wire = 0.20m
current carried by the semicircular piece of wire 150A

magnetic field is given as

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

The differential form of Biot-Savart law is given as : $dB = \frac{\mu_0 I}{4\pi} \frac{dI \sin\theta}{r^2}$ $B = \frac{\mu_0}{4\pi} I \int \frac{dI \times \hat{r}}{r^2}$

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

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

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Q No 2 b) A circular coil of radius 5×10^{-2} m and and with 40 turns is carrying a current of 0.25 A. Determine the magnetic field of the circular coil at the center.

Ans:- A radius of circular coil $= 5 \times 10^{-2}$ m
Number of turns of the circular coil = 40
current carried by the circular coil = 0.25 A

Magnetic field is given as

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

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

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

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Q No 2 a):: Compute the magnetic field of a long straight wire that has a circular loop with a radius of 0.05 m.

2amp is the reading of the
current flowing through this closed loop.

Solution:-

Given

$R = 0.05\,m$

$I = 2\,amp$

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

Ampere's law formula is

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

In the case of long straight wire

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

$= 0.314$

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

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

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

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

Q No 2 b) :: with the cylinder $\rho = 2, 0 \le z \le 1$, 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 with in the cylinder?

Solution:-

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 $E_P =$ ~~[illegible]~~

$$= -179.9\,a_\rho - 75.0\,a_\phi \text{ V/m}$$

Now

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

$$\rho_v = \nabla \cdot D = \left(\frac{1}{\rho}\right)\frac{d}{d\rho}(\rho D_\rho) + \frac{1}{\rho}\frac{\partial D_\phi}{\partial \phi} = \left[-\frac{1}{\rho}(50 + 150\sin\phi) + \frac{1}{\rho}150\sin\phi\right]\epsilon_0$$

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

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At ρ, This is $\rho_v\rho = -445\,pC/m^3$.

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

$$Q = \int_0^2\int_0^{2\pi}\int_0^2 -\frac{5\bar{e}\,\epsilon_0}{\rho}\,\rho\,d\rho\,d\phi\,dz$$

$$Q = -2\pi(5\bar{e})\epsilon_0(2)$$

$$\boxed{Q = -5.56\,nC}$$

Q NO 3 a):-

Given the time varying 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 $(-2,-3,0)$, Find the time varying current following in the general a_ϕ direction if the total loop resistance is $400\,K\Omega$.

solution:- $$emf = \oint E\cdot dL = -\frac{d\phi}{dt} = \frac{d}{dt}\iint_{loop\ area} B\cdot a_z\,da$$

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

where the loop normal is choosen as positive a_z, so that the path integral for E is taken around the positive a_ϕ direction. Taking the derivative, we find

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

$$= -\frac{36000 \sin 5000t}{400 \times 10^3} = -90 \sin 5000t \text{ mA}$$

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