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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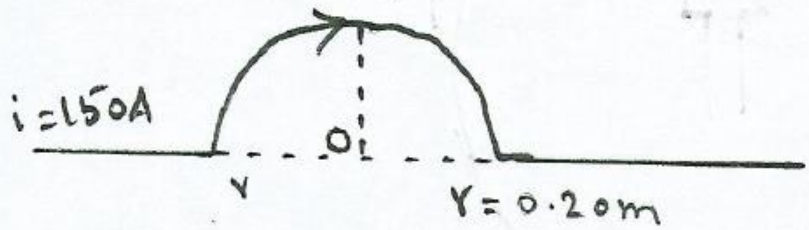
Q1: Solve the following short Question	**(a)**	Determine the magnetic field at the center of the semicircular piece of wire with radius 0.20m. The current carried by the semicircular of wire is 150A.	**Marks 10** **CLO 2**
	(b)	A circular coil of radius 5×10^{-2} m and with 40 turns is carrying a current 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**

Q1:

(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

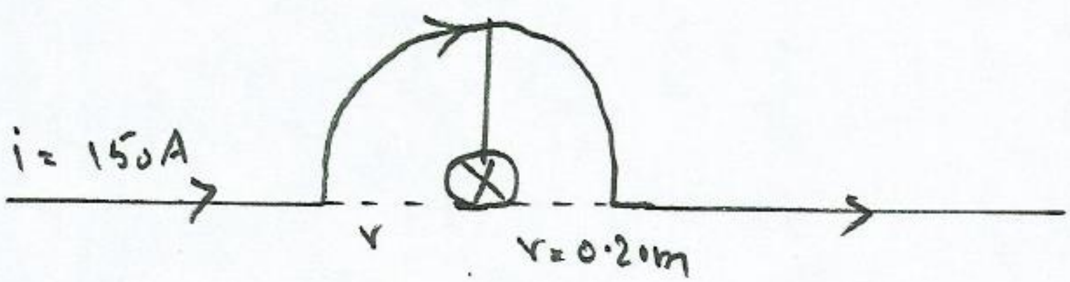


when we apply right hand rule we see that the direction of magnetic field is inward.
Since we have semicircle.

So we put 1/2 in formula

$$B = 2\pi K \cdot \frac{i}{r}$$

$$B = \frac{1}{2} 2\pi K \frac{i}{r}$$



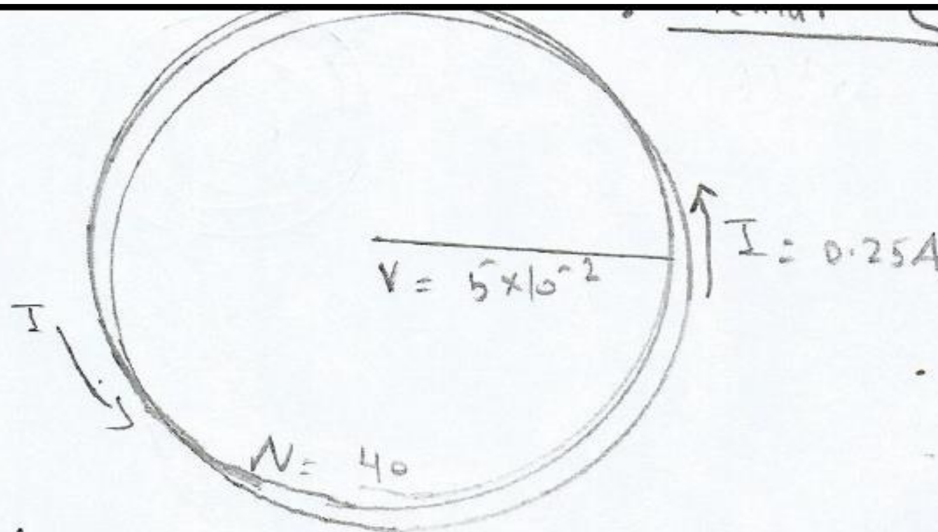
$$B = \frac{1}{2} 2\pi K \frac{i}{r}$$

$$B = \frac{1}{2} 2 \cdot 3.141 \times 10^{-7} \times \frac{150}{0.20}$$

$$B = 2.\cancel{35}575 \times 10^{-4} \frac{N}{Amp.m}$$

$$= 2.355 \times 10^{-4} N\,Amp^{-1} m^{-1}$$

(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



Given data:-

Current = I = 0.25 A

Radius = r = 5×10^{-2}

Number of turns = N = 40

Using equation

$$B = \mu_o N \frac{I}{2R}$$

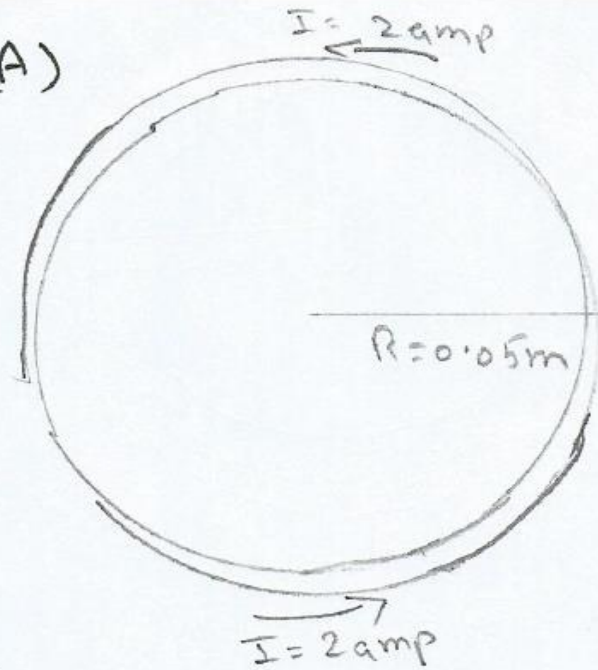
$\mu_o = 1.26 \times 10^{-6}$ Tm/A

$$\Rightarrow \frac{1.26\times10^{-6} \times 40 \times 0.25\,A}{2\,(5\times10^{-2})}$$

$$B = 1.26 \times 10^{-4}\ A \cdot m^{-1}$$

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

Q2:- Part(A)



Given data:-

$R = 0.05m$

$I = 2amp$

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

Ampere's law formula

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

In case of straight wire

$$\oint d\vec{l} = 2\pi R = 2 \times 3.141 \times 0.05 = 0.314$$

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

$$\vec{B} = \frac{\mu_0 I}{2\pi R} = \frac{4\pi \times 10^{-7} \times 2}{0.314} = 8 \times 10^{-6} T$$

(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 $(1, 60^\circ, 0.5)$ in free space. (b) How much charge lies within the cylinder?	Marks 08 CLO 2

Part(b):-

By substituting given Point we find $V_P = 279.9V$ then

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

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

Evaluating above ρ to find E_P

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

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

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

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

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

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

b) How much charge lies with the Cylinder

we integrat ρ_v over the volume to obtain

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

$$Q = -2\pi(50)\epsilon_0(2) = -5.56 nC$$

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

Q3:-

first 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 +ive a_ϕ direction. Taking derivative we find

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

So

$$I = \frac{emf}{R} = \frac{-36000 \sin 5000t}{4000 \times 10^3} = -90 \sin 5000t\ mA$$

So the time varying current flowing $-90 \sin 5000t\ mA$