Department of Electrical Engineering

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13122

Final Examination

Electro Magnetic Field Theory

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Question 1. (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.

Soliution:

The radius of the semicircular piece of wire = 0.20 m

Current carried by the semicircular piece of wire = 150 A

Magnetic field is given as: $B=\mu0NI2a$

The differential form of Biot-Savart law is given as:

$dB=\mu0I4\pi dl\sin\theta r2$

$B=\mu04\pi I\int dl\times r\hat{}r2$

$=\mu04\pi Ir2\int dl$

$=\mu04\pi Ir2\pi r$

$=\mu0I4r$

$=4\pi\times10-7T.m/A(150A)4(0.20m)$

$=2.4\times10\text{-}4$ T

Question 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.

Soliution:

The radius of the circular coil = 5×10^{-2}m

Number of turns of the circular coil = 40

Current carried by the circular coil = 0.25 A

Magnetic field is given as: $B=\frac{\mu 0NI}{2a}$

$= \frac{4pai \times 10 - 7T.m/A(40) \quad 0.25A}{2.50 \times 10 - 瞒}$

= 1.2×10^{-4} T

Question 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.

Solution:

R = 0.05m

I = 2amp

$\mu 0 = 4\pi\times10^{-7}N/A^2$

Ampere's law formula is

$\oint \vec{B} \quad dl_{\rightarrow} = \mu 0 I$

In the case of long straight wire

$\oint dl_{\rightarrow} = 2\pi R$

= 2×3.14×0.05m

= 0.314

$B \oint dl_{\rightarrow} = \mu 0I$

$\vec{B} = \mu 0I \,/\, 2\pi R$

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

$\vec{B} = 8\times10^{-6} T$

Question 2. (B)

Within the cylinder ρ = 2, 0 < z < 1, the potential is given by V = 100 + 50ρ+ 150ρsinφV.
Solution.

a). Find V, E, D, and ρv at P (1,60◦,0.5) in free space: First, substituting the given point,we find V P = 279.9 V. Then,
$E=-\nabla V = (-\partial V / \partial \rho)a\rho - (1/\rho)(\partial V / \partial \varphi)(a\varphi)$
$=-[50 + 150\sin\varphi]a\rho - [150\cos\varphi]a\varphi$
Evaluate the above at P to find EP =−179.9aρ−75.0aφ V/m
Now D= ϱ0E, so
DP =−1.59aρ−.664aφ nC/m². Then
$\rho v = \nabla\cdot D = (1/\rho)(d/d\rho)(\rho D\rho) + (1/\rho)(\partial D\varphi/\partial\varphi)$
$= [-1/\rho(50 + 150\sin\varphi) + (1/\rho)150\sin\varphi]\, \varrho 0 = -50/\rho\, \varrho 0$ C
At P, this is
ρvP = −443 pC/m³

b) How much charge lies within the cylinder? We will integrate ρv over the volume to obtain:
$Q = (-50\varrho 0/\rho)\ \rho\, d\rho\, d\varphi\, dz$
$= -2\pi(50)\varrho 0(2)$
= −5.56 nC

QUESTION 3.

Given the time-varying magnetic field, B = (0.5ax +0.6ay −0.3az)cos5000t T, and a square fila-mentary loop with its corners at (2,3,0), (2,-3,0), (-2,3,0), and (-2,-3,0), find the time-varying currentflowing in the general aφ direction if the total loop resistance is 400 k.

Solution:

As we know that;

$$\text{emf} = \oint \mathbf{E}\cdot d\mathbf{L} = -d\Phi / dt = -d / dt \int \int_{Looparea} \mathbf{B}\cdot\mathbf{a}_z \, da = d / dt\, (0.3)(4)(6)\cos 5000t$$

Where the loop 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

$\text{emf} = -7.2(5000)\sin 5000t$

so that

$I = \text{emf} / R$

$= -36000\sin 5000t \;/\; 400\times10^3$

$= -90\sin 5000t$ mA