SE415

Total No. of Printed Pages:4

S.E. (Electronics & TC / Electronics & Comm Engg) (Sem-IV)
(Revised Course 2016-2017) EXAMINATION Nov/Dec 2019
Electromagnetic Fields and Waves

[Duration : Three Hours] **[Total Marks : 100]**

Instructions :-

1) Answer **five** questions.
2) Assume missing data if any.
3) Figures to the **right** indicates **marks**.

PART A

Answer any two questions from the following:

1.

a. Given point P (-2, 6, 3) and vector $\vec{A} = y\overrightarrow{a_x} + (x+z)\overrightarrow{a_y}$ express P and $\vec{A}$ in cylindrical coordinate system. Evaluate $\vec{A}$ at P in cylindrical system. **6**

b. Express the following vector in Cartesian coordinates and find B(-3, 4, 0) **6**
$\vec{B} + \frac{10}{r}\overrightarrow{a_r} + r\cos\theta\overrightarrow{a_\theta} + \overrightarrow{a_\varphi}$

c. If $G(r) = 10e^{-2z}(\rho\,\overrightarrow{a_\rho} + \overrightarrow{a_z})$, determine the flux of G out of entire surface of the cylinder $\rho = 1, 0 \le z \le 1$. Confirm the result using the divergence theorem. **8**

2.

a. Point charges 5nC and -2 nC are located at (2, 0, 4) and (-3, 0, 5), respectively. **10**
(i) Determine the force on a 1-nC point charge located at (1, -3, 7)
(ii) Find the electric field E at (1, -3, 7)

b. Planes x=2 and y=-3, respectively, carry charges 10 nC/m^2 and 15 nC/m^2. If the line x=0, z=2 carries charge 10π nC/m, calculate E at (1, 1, -1) due to three charge distributions. **10**

3.

a. A thin ring of radius 5 cm is placed on plane z=1 so that its center is at (0, 0, 1cm). If the ring carries 50 mA along $\overrightarrow{a_\varphi}$, find H at **10**
i) (0, 0, -1cm)
ii) (0, 0, 10 cm)

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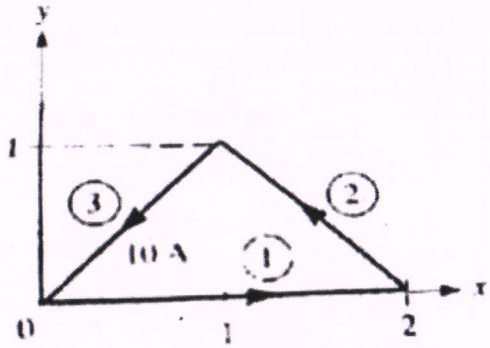
b. Find H at (0, 0, 5) due to side 2 of the triangular loop in Figure. Also find H due to entire loop. **10**



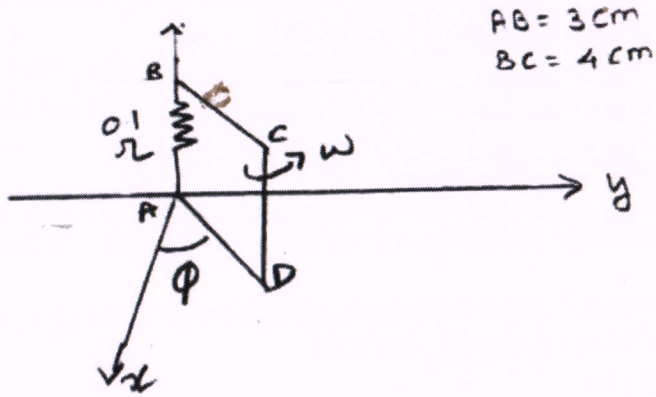
PART B

Answer any two questions from the following:

4. a. The loop shown in Figure is inside a uniform magnetic field $B = 50\overrightarrow{a_y}\text{mWb/m}^2$. If side DC of the loop cuts the flux lines at the frequency of 80 Hz and the loop lies in the yz-plane at time t = 0, find **10**

(i) The induced emf at t = 1 ms

(ii) The induced current at t = 3 ms



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b. The electric field and magnetic field in free space are given by

$$\vec{E} = \frac{50}{\rho}\cos(10^6 t + \beta z)\,\overrightarrow{a_\varphi}\ V/m$$

$$\vec{B} = \frac{H_0}{\rho}\cos(10^6 t + \beta z)\,\overrightarrow{a_\rho}\ A/m$$

Express these in phasor form and determine the constants H_0 and β such that the fields satisfy Maxwell's equations.

5. a. State and derive Poynting's theorem. Give its significance. **8**

b. Derive the time dependent source free electromagnetic wave equation for magnetic field intensity **8**

c. Explain Lenz's law. **4**

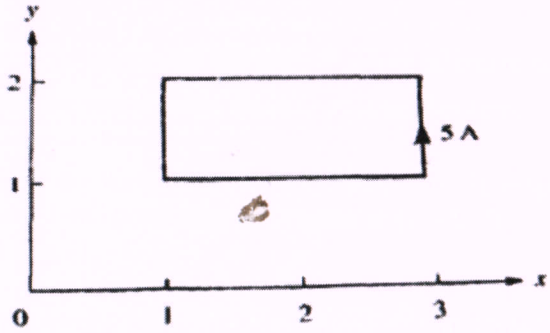
6. a. What are Guided waves? Derive the expression for the field components of TE waves between two parallel planes. **8**

b. The plane wave $\vec{E} = 50\sin(\omega\, t - 5\, x)\, \widehat{a_y} V/m$ in a lossless medium ($\mu = 4\mu_0$ & $\epsilon = \epsilon_0$) encounters a lossy medium ($\mu = \mu_0$ & $\epsilon = 4\epsilon_0$ & $\sigma = 0.1\ S/m$) normal to the x-axis at x=0. Find Reflection coefficient (Γ), transmission coefficient (T), standing wave ratio (S), reflected waves $(\overrightarrow{E_r})$& $(\overrightarrow{H_r})$ and transmitted waves $(\overrightarrow{E_t})$ & $(\overrightarrow{H_t})$. **12**

PART C

Answer any one questions from the following:

7. a. Given $\vec{B} = 6x\, \overrightarrow{a_x} - 9y\, \overrightarrow{a_y} + 3z\, \overrightarrow{a_z}\ Wb/m^2$, find the total force experienced by the rectangular loop (on z=0 plane) shown in Figure **6**



b. List the differential, integral and time-harmonic representation of Maxwell's equations. **6**

c. In free space $\vec{H} = (\rho \sin\phi\, \overrightarrow{a_\rho} + 2\,\rho\cos\phi\, \overrightarrow{a_\varphi})\cos(4\times 10^6\, t)\ A/m$. Find displacement current density J_D and Electric field intensity $\vec{E}$. Assume the medium is charge free. **8**

8. a. Explain the wave propagation through Good conductor. What is skin depth? Give its significance. **6**

b. What is wave polarization? List different types of polarization. **4**

c. Determine $\beta, \alpha, \lambda, v$ for rubber at $f = 10^{16} Hz$. Given $\epsilon_r = 3.5, \sigma = 10^{-16} S/m$ *and* $\mu_r = 1$. **4**

d. Show that another form of Faraday's law is $\vec{E} = -\frac{\partial \vec{A}}{\partial t}$, where $\vec{A}$ is vector magnetic potential. **6**