Sr. No. of Question Paper: 3375

Unique paper Code : **32511503**

Name of the Paper : **Electromagnetics (Core)**

Name of Course : **B.Sc.(H) Electronics CBCS**

Semester : **V**

Duration: 3 Hours Maximum Marks :75

(*Write your Roll No. on the top immediately on receipt of this question paper*)

Attempt *five* questions in all, including question no. 1 which is **compulsory**.

Non-programmable scientific calculator is allowed.

All questions carry equal marks.

Q.1 (a) Transform: (3)

$\vec{A} = y\,\hat{a}_x + x\,\hat{a}_y + \frac{x^2}{\sqrt{x^2+y^2}}\,\hat{a}_z$ to cylindrical coordinates.

(b) Given $\vec{D} = \frac{Q}{\pi r^2}(1 - \cos 3r)\,\hat{a}_r$ in spherical coordinates, find the charge density. (3)

(c) State ampere's circuital law. Obtain expression for ampere's circuital law in point form. (3)

(d) A parallel plate capacitor with plate area of 5 cm^2 and plate separation of 3mm has a voltage 50 $\sin(10^3 t)$ V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$. (3)

(e) Find the skin depth at a frequency of 1.6 MHz in aluminum, where $\sigma = 38.2$ MS/m and $\mu_r = 1$. Also find the propagation constant and wave velocity. (3)

Q.2 (a) Use Gauss's theorem to find the electric field intensity $\vec{E}$ and Electric flux density $\vec{D}$ due to a uniformly charged sphere having uniform charge density ρ at a point (8)

(i) outside the sphere and

(ii) inside the sphere.

Also sketch variation of $\vec{D}$ with the distance from the center of sphere.

(b) The point charges -1nC, 4nC and 3nC are located at (0, 0, 0), (0, 0, 1) and (1, 0, 0), respectively. Find the energy in the system. (5)

(c) In a cylindrical conductor of radius 2mm, the current density varies with the distance from the axis according to $J = 10^3 e^{-400\rho}$ (A/m^2). Find the total current. (2)

Q.3 (a) Derive the continuity of the current equation. Solve the equation to obtain an (8) expression for the volume charge density in terms of relaxation time. Explain why a charge inside a good dielectric remains wherever placed.

(b) Obtain an expression for magnetic flux density due a magnetic dipole. Draw the magnetic flux density lines. (7)

Given the magnetic vector potential $\vec{A} = \frac{-\rho^2}{4}\,\hat{a}_z$ Wb/m, calculate the total magnetic flux crossing the surface $\emptyset = \frac{\pi}{2}, 1 \leq \rho \leq 2\,m, 0 \leq z \leq 5\,m$

Q.4 (a) State and explain the boundary conditions that are applied to a magneto-static field at an interface between two magnetic media. (6)

(b) Determine the self-inductance of a coaxial cable of inner radius "a" and outer radius "b". (6)

(c) Find expression for the energy in a magneto-static field in terms of $\vec{B}$ (3)

Q.5 (a) What are the transformer and the motional $e.m.f.$s? Obtain an expression for them. Show that the time-varying $\vec{E}$ field is not conservative. (7)

(b) If a medium is characterized by $\sigma = 0, \mu = \mu_0$ *and* $\varepsilon = 4\varepsilon_0$ and (8)

$\vec{E} = 20\sin(10^8 t - \beta z)\,\hat{a}_y$ V/m

Calculate β and $\vec{H}$.

Q.6 (a) Given that $\vec{A} = 10\cos(10^8 t - 10\,x + 60°)\,\hat{a}_z$ and (6)

$\vec{B_s} = \left(20/_j\right)\hat{a}_x + 10\,e^{j2\pi x/3}\,\hat{a}_y.$

Express $\vec{A}$ in phasor form and $\vec{B_s}$ in instantaneous form.

(b) Define a mode. Discuss various types of modes supported by a rectangular metallic waveguide. Derive the field expressions for TM modes that exist in metallic rectangular waveguide. Also obtain expressions for propagation constant and the cut off wavelength. (9)

Q.7 (a) Derive the expression for propagation constant of a wave propagating in a lossy medium. Also find the expression for the intrinsic impedance of the medium. (8)

(b) In a non-magnetic medium (7)

$\vec{E} = 4\sin(2\pi \times 10^7 t - 0.8\,x)\,\hat{a}_z$ V/m

Find

(i) ε_r *and* η

(ii) The time average power carried by the wave.

Relevant Physical constants:

$\mu_o = 4\pi \times 10^{-7}$ H/m

$\varepsilon_o = 8.85 \times 10^{-12}$ F/m

$c = 3 \times 10^{8}$ m/s

$e = 1.6 \times 10^{-19}$ C