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Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **1094**

Unique Paper Code : **251405** **E**

Name of the Paper : **Electromagnetics (ELHT-403)**

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

Semester : **IV**

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.

Scientific calculator is allowed.

All questions carry equal marks.

1. (*a*) Calculate the magnetic flux density B at the centre of a current carrying loop when the radius of loop is 2.0 cm, loop current is 1.0 mA and loop is placed in air.

(*b*) In a material for which σ = 5.0 S/m and ε_r = 1, the electric field intensity is given as E = 250 sin 10^{10} t(V/m). Find the conduction and displacement current densities.

(*c*) Write the Laplace's equation in cartesian, cylindrical and spherical co-ordinates.

(*d*) Given that D = 10 × a_x (C/m^2), determine the flux crossing 1.0 m^2 area that is normal to the x-axis at x = 3.0 m.

(*e*) Using the Gauss's law in electrostatics, find the electric field intensity due to an infinite line of charge. 5×3

P.T.O.

2. (*a*) Explain the physical significance of :

(*i*) Gradient

(*ii*) Divergence

(*iii*) Curl. 6

(*b*) Write the expression for incremental lengths in the cartesian, cylindrical and spherical co-ordinate system. 3

(*c*) Point charges 1 mC and –2 mC are located at (3, 2, –1) and (–1, –1, –4) respectively. Calculate the electric force on a 20 nC charge located at (0, 3, 1) and also the electric field intensity at that point. 6

3. (*a*) What is capacitance ? Derive an expression for the capacitance of parallel plate capacitor. 5

(*b*) Using Laplace's equation find the potential function and electric field intensity for the region between two concentric right circular cylinders, where V = 0 at r = 1.0 mm and V = 150 volts at r = 20.0 mm. 5

(*c*) What do you understand by polarization in dielectrics ? Define the terms dielectric strength and dielectric constant. 5

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

(*i*) outside the sphere and

(*ii*) inside the sphere.

Also sketch variation of $\vec{D}$ with the distance from the centre of sphere 'r'. 8

(*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 2 mm, the current density varies with the distance from the axis according to $J = 10^3 e^{-400r} (A/m^2)$. Find the total current I. 2

5. (*a*) Derive Biot-Savart's Law and Ampere's circuital law using the concept of magnetic vector potential $\vec{A}$. 6

(*b*) Planes $z = 0$ and $z = 4$ carry current $k = -10a_x$ (A/m) and $k = 10a_x$ (A/m) respectively. Determine H at :

(*i*) (1, 1, 1)

(*ii*) (0, –3, 10). 5

(*c*) A solenoid 20.0 cm long and 1.0 cm in diameter has 100 turn winding. If this is placed in uniform magnetic field of strength 2.0 Wb/m^2 and current of 10 A, calculate the maximum torque on the solenoid. 4

6. (*a*) Write the differential and integral form of four Maxwell's equations and explain their physical significance. 8

(*b*) A parallel plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage 50 sin $10^3 t$(V) applied to its plates. Calculate the displacement current assuming $\epsilon = 2\epsilon_0$. 5

P.T.O.

(*c*) Starting from Maxwell's equation : 2

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

prove that :

$$\vec{\nabla} \cdot \vec{B} = 0.$$

7. (*a*) Calculate the self inductance per unit length of infinitely long solenoid. 6

(*b*) In a medium characterized by

$$\sigma = 0,\ \mu = \mu_0,\ \varepsilon = \varepsilon_0 \text{ and}$$

$$\vec{E} = 20\sin(10^8 t - \beta z)\ a_y \text{ (V/m)}.$$

Calculate β and $\vec{H}$. 6

(*c*) A circular loop of 10 cm radius is located in the XY plane in a magnetic field. Determine voltage induced in the loop. Given that : 3

$$\vec{B} = 0.5 \cos 377t(3a_y + 4a_z) \text{ tesla.}$$

Relevant Physical constants :

$\mu_0 = 4\pi \times 10^{-7}$ H/m

$\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

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

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