

005 : Electromagnetic Fields

P. Pages : 2

GUG/W/22/13851

Time : Three Hours



Max. Marks : 80

- Notes :
1. All questions carry equal marks.
 2. Due credit will be given to neatness and adequate dimensions.
 3. Assume suitable data wherever necessary.
 4. Illustrate your answers wherever necessary with the help of neat sketches.
 5. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
 6. Answer **any five** questions as per internal given choice.
 7. Use of non programmable calculator is permitted.

1. a) Find the unit vector perpendicular to each of vectors 8
 $\vec{A} = 2\hat{a}_x - \hat{a}_y + \hat{a}_z$ and
 $\vec{B} = 3\hat{a}_x + 4\hat{a}_y - \hat{a}_z$
 Also find the angle between these vectors
- b) i) Find the volume defined by $3 < \rho < 8$, $25^\circ < \phi < 45^\circ$, $8 < z < 9$ 8
 ii) What is the length of the longest straight line that lies entirely within the volume?
 iii) Find total area of the surface.

OR

2. a) Transform 8
 $\vec{A} = 8xyz\hat{a}_x - 4(x + y + z)\hat{a}_z$
 in cylindrical co-ordinate and spherical co-ordinate and spherical co-ordinate.
- b) Show that the following vector field is solenoidal 8
 $\vec{A} = \sigma(\rho^2 + z^2)^{-3/2}(\rho\hat{a}_\rho + z\hat{a}_z)_\rho$
3. a) Derive an expression for the electric field Intensity due to an infinite uniform 1 charge. 8
- b) A point charge $Q_A = -1\mu\text{C}$ is located at point A (0, 0, 2) and another point charge $Q_B = -2\mu\text{C}$ is located at B (0, 0, -2). Find electric field intensity at P (1, 2, 3). 8

OR

4. a) Two identical uniform line charges of $\rho_L = 4\text{nC/m}$ are parallel to z-axis at $x = 0$, $y = \pm 4\text{m}$. Determine electric field intensity at (4, 0, z). 8
- b) Given the flux density. 8
 $\vec{D} = 6\rho \sin\left(\frac{1}{2}\phi\right)\hat{a}_\rho + 1.5\rho \cos(\phi/2)\hat{a}_\phi \text{ C/m}^2$
 Evaluate both sides of divergence theorem for the region bounded by,
 $\rho = 2$, $\phi = 0$ to π , $z = 0$ to 5

5. a) Define dipole? Derive the equation for potential & electric field intensity of the dipole and dipole moment. 8
- b) Calculate the work done in moving a 4C charge from B (1, 0, 0) to A (0, 2, 0) along the path $y = 2-2x, z=0$ in the field. 8
- i) $5a_x$ V/M ii) $5x a_x$ V/M iii) $5x a_x + 5y a_y$ V/M

OR

6. a) Show that the following vector field is solenoidal 8
- $$\vec{A} = \sigma (\rho^2 + z^2)^{-3/2} (\rho \hat{\rho} + z \hat{z})_\rho$$
- b) If 8
- $$V = \frac{60 \sin \theta}{r^2}$$
- volt in free space. Find at point P (1, 45°, 60°)
- i) E ii) dV/dN
- iii) a_N iv) ρ_v

7. a) Derive the capacitance between a conducting cone with its vertex separated from a conducting plane by an infinitesimal insulation gap and its axis normal to the plane. 8
- b) Consider concentric spherical shells in free space in which $V = 0$ volt at $r = 8\text{cm}$ and $V=20$ volt at $r = 25\text{cm}$. Find E using Laplace's equation. 8

OR

8. a) Given the potential field 8
- $$V = (A\rho^4 + B\rho^{-4}) \sin(4\phi) \text{ volts. Show that}$$
- i) $\nabla^2 V = 0$
- ii) Select A & B so that $V = 100$ volts and $|\vec{E}| = 500$ V/M at P (1, 22.5°, 2)
- b) The region $y < 0$, contains a dielectric for which 8
- $$\epsilon_{r1} = 2.5 \text{ while } y > 0 \epsilon_{r2} = 4. \text{ Let } \vec{E} = -40\hat{a}_x + 60\hat{a}_y + 80\hat{a}_z \text{ V/M. Find;}$$
- i) E_{N1} ii) \vec{E}_{t1} iii) E_1 iv) θ_1

9. a) Derive the equation for scalar magnetic potential. 8
- b) A 10GHz plane wave travelling in free space has an amplitude 30V/M. Find: 8
- i) Velocity of propagation ii) Wavelength
- iii) Amplitude of H iv) Propagation constant (β)

OR

10. a) State Maxwell's equation for time varying field in integral form. Also derive Maxwell's 2nd equation for time varying field. 8
- b) A plane wave of 9375 MHz travelling in free space has an amplitude of 20V/m. Find 8
- i) Velocity of propagation ii) Wavelength
- iii) Intrinsic impedance of medium iv) Phase shift constant B
