B.E. / B.Tech. Electrical (Electronics & Power) Engineering (Model Curriculum) Semester-III

005 / SE105 - Electromagnetic Fields

P. Pages : 3 **GUG/S/25/13851**

Time : Three Hours * 2 2 8 6 * Max. Marks : 80

Notes :
1. All questions carry equal marks.
2. Answer **any five** questions as per internal given choice.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.
6. 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.
7. Use of non programable calculator is permitted.

1. a) Find the unit vector perpendicular to each of vectors. **8**

$\bar{A} = 2\hat{a}\,x - \hat{a}\,y + \hat{a}\,z$ and

$\bar{B} = 3\hat{a}\,x + 4\hat{a}\,y - \hat{a}\,z$

Also find the angle between these vectors.

b) Express the unit vector a_x in spherical components at the point (a) r = 2, $\theta = 1$rad, $\phi = 0.8$rad; (b) x = 3, y = 2, z = –1; (c) $\rho = 2.5$, $\phi = 0.7$ rad, $z = 1.5$ **8**

OR

2. a) Transform **8**

$\bar{A} = 8xyz\,\hat{a}\,x - 4(x + y + z)\hat{a}\,z$

in cylindrical co-ordinate and spherical co-ordinate and spherical co-ordinate.

b) Given point $P(r = 0.8, \theta = 30^o, \phi = 45^o)$ and $E = 1/r^2\left[\cos\phi\, a_r + (\sin\phi / \sin\theta)a_\phi\right]$, find **8**

(a) E at P; (b) $|E|$ at P; (c) a unit vector in the direction of E at P.

3. a) Derive an expression for the electric field intensity due to an infinite uniform line charge. **8**

b) A point charge $Q_A = -1\mu C$ is located at point A (0, 0, 2) and another point charge $Q_B = -2\ \mu C$ is located at B(0, 0, -2). Find electric field intensity at P(1, 2, 3). **8**

OR

4. a) Calculate $\nabla \cdot D$ at the point specified if

i) $D = (1/z^2)\left[10xyza_x + 5x^2za_y + (2z^3 - 5x^2y)a_z\right]$ at $P(-2,3,5)$;

ii) $D = 5z^2a_\rho + 10\rho za_z$ at $P(3, -45^o, 5)$;

iii) $D = 2r\sin\theta\sin\phi a_r + r\cos\theta\sin\phi a_\theta + r\cos\phi a_\phi$ at $P(3, 45^o, -45^o)$;

b) Two point charges –4uC and 5 uC are located at (2, -1, 3) and (0, 4, -2) respectively. Find the potential at (1, 0, 1) assuming zero potential at infinity. **8**

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) $5\ a_x V/M$

ii) $5x\ a_x V/M$

iii) $5x\ a_x + 5y\ a_y V/M$

OR

6. a) Prove the uniqueness theorem for Laplace equations. **8**

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 cm and V = 20 volt at r = 25 cm. Find E using Laplace's equation. **8**

OR

8. a) Given the potential field. **8**

$V = \left(A\rho^4 + B\rho^{-4}\right)\sin(4\phi)$ volts. Show that

i) $\bar{\nabla}^2 V = 0$

ii) Select A & B so that V = 100 volts and $\left|\bar{E}\right| = 500\,V/M$ at $P(1, 22.5^\circ, 2)$.

b) The region y < 0 contains a dielectric for which $\in_\eta = 2.5$ while y > 0 is characterized by **8**

$\in_{r_2} = 4$. Let $\bar{E} = -40\,\hat{a}\,x + 60\,\hat{a}\,y + 80\,\hat{a}\,z\,V/M$ Find:

i) E_{N_1} ii) $\bar{E}_{t_1}$

iii) E_1 iv) Θ_1

9. a) Derive the equation for scalar magnetic potential. **8**

b) A 10 GHz plan wave travelling in free space has an amplitude 30 V/M. **8**
Find:

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 2^{nd} equation for time varying field. **8**

b) A plane wave of 9375 MHz travelling in free space has an amplitude of 20 V/m. **8**
Find

i) Velocity of propagation.

ii) Wavelength.

iii) Intrinsic impedance of medium.

iv) Phase shift constant B.

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