M.Sc. First Semester (Applied Electronics) (New) (CBS)

# 15004 : Electric & Magenetic Fields : 1 AE 4

P. Pages : 2 | AU - 3179

Time : Three Hours | Max. Marks : 80

Notes : 1. Assume suitable data wherever necessary.
2. Illustrate your answer necessary with the help of neat sketches.

1. a) Express the following vector: 6

$$B = \frac{10}{r}\bar{a}r + r\cos 0\,\bar{a}\theta + \bar{a}\phi$$

in cartesian and cylindrical coordinate system.

b) The vector from the origin to point A is given as $6\bar{a}x - 2\bar{a}y - 4\bar{a}z$ and unit vector directed from origin to point B is $\left(\frac{2}{3}, \frac{-2}{3}, \frac{1}{3}\right)$. If points A and B are 10 units apart, find coordinates of point B. 7

**OR**

2. a) Define the following terms and give their physical interpretation 7
i) Gradient ii) Divergence
iii) Curl.

b) A triangle is defined by three points, A(2,–5,1), B(–3,2,4) and C(0,3,1). 6
Find :
i) $\bar{R}_{BC} \times \bar{R}_{BA}$, ii) The area of triangle; and
iii) A unit vector that is perpendicular to the plane in which the triangle is located.

3. a) Show that electric field intensity is negative gradient of potential. 5

b) A uniform line charge of 16n C/m is located along the line defined by $y = -2, z = 5$. 9
If $\epsilon = \epsilon_0$: Find-
i) E at P(1,2,3) and
ii) E at that point in the z = 0 plane where the direction of E is given by $\frac{1}{3}\bar{a}y - \frac{2}{3}\bar{a}z$.

**OR**

4. a) Evaluate both sides of Divergence theorem for the field $\bar{D} = 2xy\,\bar{a}x + x^2\,\bar{a}y\ C/m^2$ and the rectangular parallelepiped formed by the planes x = 0 and 1, y = 0 and 2, and z = 0 and 3. 8

b) An infinite plane has uniform charge density $\rho_s\ C/m^2$. Derive the expression of electric field intensity for this symmetric uniform sheet of charge. 6

5. a) Derive the expression for magnetic field intensity at any point due to infinite current carrying conductor. 7

b) A current filament of $3\bar{a}x$ A lies along x-axis. Find H in the cartesian components at P(–1,3,2). 6

**OR**

6. a) Explain the following. 6
i) Biot-Savart's law.
ii) Ampere's circuital law.

b) Evaluate any side of Stoke's theorem for the field $\bar{G} = 10\sin\theta\,\bar{a\phi}$ and the surface $r = 3, 0 \le \theta \le 90°$ and $0 \le \phi \le 90°$. Let the surface have the $\bar{ar}$ direction. 7

7. a) Prove the following equation: 6

$\bar{\nabla} \times \bar{H} = \bar{J} + \frac{\partial \bar{D}}{\partial t}$. for time-varying field where symbols have their usual meaning.

b) Region $y < 0$ contains a perfect conductor while region $y > 0$ is a dielectric medium with permittivity of 2. If there is a surface charge of $2n\ C/m^2$ on the conductor find E and D at (i) A(3, –2, 2) (ii) B(–4, 1, 5). 7

OR

8. a) Derive the magnetic boundary condition for two different magnetic materials. 6

b) Given that $H_1 = -2\bar{ax} + 6\bar{ay} + 4\bar{az}$ A/m in the region $y - x - 2 \le 0$, where $\mu_1 = 5\mu_o$. 7

Evaluate.

i) $M_1$ and $B_1$.

ii) $H_2$ and $B_2$ in the region $y - x - 2 \ge 0$, where $\mu_2 = 2\mu_o$.

9. a) A uniform plane wave propagating in a medium has 8

$\bar{E} = 2e^{-\alpha z}\sin\left(10^8 t - \beta z\right)\bar{ay}\ \ V/m$

If the medium is characterized by $\epsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3$ S/m.

Evaluate $\alpha, \beta$ and H.

b) For a perfect conductor deduce the following relationship : $\alpha = \beta$. 6

OR

10. a) Derive Poynting theorem and give significance of various terms in the theorem. 8

b) An EM wave travels in free space with electric field component 6

$Es = 100\,e^{j(0.866y - 0.5z)}\bar{ax}\ \ V/m.$

Evaluate :

i) $\omega$ and $\lambda$. ii) Magnetic field component.

iii) Time average power in wave.

11. a) Prove that field due to alternating small current element contains radiation, induction and the electrostatic component. 7

b) An Array of isotropic antennas is operated at frequency of 10GHz. Find null to null beam width and directivity for – 6

i) Broadside array with array length 6m.

ii) End fire array with 20 radiators and inter element spacing of $0.5\lambda$.

OR

12. Assuming a sinusoidal current distribution, derive expression for field radiated by half wave dipole. 13

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