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

15004 : Electric & Magnetic Fields

1 AE 4

P. Pages : 2 | **AV - 3294**

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) Given two vectors $\bar{r}_A = -\hat{a}_x - 3\hat{a}_y - 4\hat{a}_z$, $\bar{r}_B = 2\hat{a}_x + 2\hat{a}_y + 2\hat{a}_z$ and point C(1, 3, 4) Find **7**

i) $R_{\overline{AB}}$ ii) $|\bar{r}_A|$

iii) $\hat{a}_A$ iv) $\hat{a}_{AB}$

v) A unit vector directed from point C to point A.

b) A triangle is defined by three points A(2, −5, 1), B(−3, −3, 2) and C(0, 9, 1) find : **6**

i) $R_{\overline{BC}} \times R_{\overline{BA}}$ ii) The area of triangle

iii) a unit vector perpendicular to the plane in which triangle is located.

OR

2. a) Express the vector field $\bar{w} = (x - y)\hat{a}_y$ in cylindrical coordinates. Also find the field $\bar{F}$ in cartesian coordinate if $\bar{F} = \rho \cos \phi \, \hat{a}_\rho$. **7**

b) Express the temperature field $T = 240 + z^2 - 2xy$ in spherical coordinate and find the density at P(−2, −5, 1), if the density is $r.e^{-r/2}(5 + \cos\theta + \sin\theta \cdot \cos\phi)$. **6**

3. a) Four infinite sheets of charge are located as follows, $20\,PC/m^2$ at y = 7, $-8\,PC/m^2$ at y = 3, $6\ PC/m^2$ at y = −1 and $-18\,PC/m^2$ at y = −4 find $\bar{E}$ at **7**

i) (2, 6, 4) ii) (−1, 0, 0) iii) $(10^6, 10^6, 10^6)$

b) Calculate the total charge within each of the indicated volumes **6**

i) $\rho_v = 10z^2 e^{-0.1x} \sin(\pi y); -1 \le x \le 2$

$0 \le y \le 1$ and $3 \le z \le 3.6$

OR

4. a) Value charge density $\rho_v = 40xyz\ c/m^3$ exists for x, y and z positive. Find total charge in the region **7**

i) $0 \le x, y$ and $z \le 2$ ii) $x = 0, y = 0, 0 \le 2x + 3y \le 10, 0 \le z \le 2$

b) Find electric field intensity due to uniform ring of charge at a point on its axis. **6**

5 a) A circular filament of radius 2m is placed in y = 0 plane, centered at origin. The filament carries a current of 10 mA in counter clockwise direction as viewed from y = 10m, find $\bar{H}$ at (0, −7, 0). **7**

b) A current sheet $\bar{k} = 2.4\,\hat{a}_z$ A/m is present at the surface $\rho = 1.2$ in free space find 7

i) $\bar{H}$ for $\rho = 1.2$ & find Vm_p at point p(1.5, 0.6π, 1) if $V_m = 0$ at $\phi = 0$ and there is a barrier at $\phi = \pi$.

OR

6. Working in cylindrical coordinates with $\bar{A} = 2\rho^2(z+1)\sin^2\phi\,\hat{a}_\phi$, evaluate both sides of stokes theorem for portion of cylindrical surface defined by $\rho = 2$, $\frac{\pi}{4} < \phi < \pi/2$, $1 < z < 1.5$ and for its perimeter. Assume $\bar{ds} = ds\,\hat{a}_\rho$ 14

7. a) Prove the following equation for time varying field $\nabla \times \bar{H} = \bar{J} + \frac{\partial \bar{D}}{\partial t} = \epsilon\frac{\partial \bar{E}}{\partial t}$ 6

b) In a material for which $\sigma = 5\mho/m$, $\epsilon_\Omega = 1$, the electric field intensity is $E = 250 \sin(10^{10} t)$ V/m. Find conduction current density and displacement current density. Also find the frequency at which they have equal amplitudes. 7

OR

8. a) Derive the electric boundary conditions for conductor-dielectric interface. 7

b) State and briefly explain Maxwell's equations for time-varying field in point form and integral form. 6

9. a) Derive the poynting theorem and give its significance. 7

b) For perfect conductor, prove that $\alpha = \beta$. 7

OR

10. a) For uniform plane wave prove that the relationship between magnitude of electric and magnetic field, $E = \sqrt{\frac{jw\mu}{\sigma + jw\epsilon}}\,H$ 7

b) An EM wave travels in free space with electric field component. 7
$E_S = 1000\,e^{j(0.866y+0.5z)}\,\overline{ax}$ V/m calculate

i) w and λ ii) magnetic field component

iii) time average power in wave.

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

OR

12. a) An array of isotropic antenna is operated at a frequency of 18 GHz, find beam width and directivity for - 7

i) Broadside array with array length of 10 m

ii) End fire array with 30 radiators and interelement spacing of 0.5λ

b) Explain Retarded potential in detail. 6

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