AR–2531

Faculty of Engineering & Technology

M.Sc. (Applied Electronics) Semester–I (New) (C.B.S.) Examination

ELECTRIC AND MAGNETIC FIELDS

(15004)

Paper—1 AE 4

Sections—A&B

Time : Three Hours] [Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Answer **THREE** questions from Section A and **THREE** questions from Section B.

(3) Assume suitable data wherever necessary.

(4) Illustrate your answers wherever necessary with the help of neat sketches.

(5) Retain the construction lines.

SECTION—A

1. (a) Express the unit vector $\mathbf{a}_x$ in spherical components at the point :

(i) $x = 3, y = 2, z = -1$;

(ii) $\rho = 2.5, \phi = 0.7$ rad, $z = 1.5$. 7

(b) AB extends from A(1, 2, 3) to B. If length of AB is 10 units and its direction is given by $a = 0.6\ a_x + 0.64\ a_y + 0.48\ a_z$ then find co-ordinates of point B. 6

OR

2. (a) The surfaces $r = 2$ and 4, $\theta = 30°$ and 50°, and $\phi = 20°$ and 60° identify a closed surface. Find :

(i) The enclosed volume;

(ii) The total area of the enclosing surface. 7

(b) Find the gradient of the following scalar fields :

(i) $U = \rho^2 z \cos 2\phi$

(ii) $W = 10\ r \sin^2\theta \cos\phi$ 6

3. (a) Derive an expression for the electric field intensity $\bar{E}$ due to a infinitely extended uniform surface charge density ρ_s. 6

(b) Evaluate both sides of the divergence theorem for the field $\mathbf{D} = 2xy\mathbf{a}_x + x^2\mathbf{a}_y$ C/m² and the rectangular parallelepiped formed by the planes x = – 1 and 1, y = 1 and 2 and z = 0 and 3. 8

OR

4. (a) The cylindrical surface $\rho = 8$ cm contains the surface charge density, $\rho_s = 5e^{-20|z|}$ nC/m². How much electric flux leaves the surface $\rho = 8$ cm, 1 cm < z < 5 cm, $30^0 < \phi < 90^0$? 7

(b) Given the potential field in cylindrical coordinates, $V = \frac{100}{(z^2+1)}\rho\cos\phi$ V, and point P at $\rho = 3$ m, $\phi = 60^0$, z = 2 m, find values at P for (a) V; (b) **E**; (c) E; (d) dV/dN; (e) $\mathbf{a}_N$ 7

5. (a) Drive an expression for magnetic field intensity due to an infinitely long straight filament carrying a direct current I along z axis. 6

(b) State and prove stokes theorem. 7

OR

6. (a) Evaluate both sides of Stokes' theorem for the field $H = 6xya_x - 3y^2a_y$ A/m and the rectangular path around the region, $2 \le x \le 5$, $-1 \le y \le 1$, z = 0. Let the positive direction of d_S be a_z. 7

(b) Explain the following :

(i) Scalar magnetic potential

(ii) Vector magnetic potential. 6

SECTION—B

7. (a) Let Region 1($z < 0$) be composed of a uniform dielectric material for which $\varepsilon_r = 3.5$, while Region 2($z > 0$) is characterized by $\varepsilon_r = 2.2$. Let $\mathbf{D1} = -50\mathbf{a}x + 30\mathbf{a}y + 20\mathbf{a}z$ nC/m^2 find :

(i) $\mathbf{D}_{N1}$, (ii) $\mathbf{D}_{t1}$,

(iii) θ_1, (iv) $\mathbf{D}_{N2}$,

(v) $\mathbf{D}_{t2}$, (vi) θ_2 8

(b) Derive the boundary conditions for two perfect dielectrics and hence show :

$$D_2 = D_1\sqrt{\cos^2\theta_1 + \left(\frac{\in_2}{\varepsilon_1}\right)^2 \sin^2\theta_1}$$ 5

OR

8. (a) Obtain magnetic boundary condition and show that :

$$M_{t2} = \frac{\chi_{m2}}{\chi_{m1}} M_{t1} - \chi_m k$$

Where χ_m is magnetic susceptibility and

k is surface current 7

(b) Derive the Maxwell's equation for time varying field in integral form. 6

9. (a) Derive the wave equations and write its phasor form. 7

(b) State and prove poynting theorem. Describe each term of poynting theorem. 7

OR

10. (a) Discuss the reflection of a plane wave incident normally on an interface between two different media in terms of reflection and transmission coefficient. 7

(b) The phasor magnetic field intensity for a 100 MHz uniform plane wave propagating in a certain lossless material is $(4a_y - j3a_z)e^{-j20x}$ A/m. Knowing that the maximum amplitude of E is 1800 V/m, find β, ε, λ, v_p, μ_r, ε_r. 7

11. (a) Describe uniform linear array and obtain its radiation pattern. 5

(b) Derive expression for induction and radiation fields for current elements. 8

OR

12. (a) Derive expression for beam width of an end-fire array. 5

(b) Obtain the radiation resistance for a short dipole and monopole. 8