Nov-Dec 2011

Total No. of Questions—12] [Total No. of Printed Pages—4+2

[4062]-158

S.E. (E & TC) (Second Semester) EXAMINATION, 2011

ELECTROMAGNETICS

(2008 PATTERN)

Time : Three Hours **Maximum Marks : 100**

N.B. :— (*i*) Answer Q. No. **1** or Q. No. **2**, Q. No. **3** or Q. No. **4**, Q. No. **5** or Q. No. **6**, Q. No. **7** or Q. No. **8**, Q. No. **9** or Q. No. **10**, Q. No. **11** or Q. No. **12**.

(*ii*) Neat diagrams must be drawn wherever necessary.

(*iii*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*iv*) Assume suitable data, if necessary.

SECTION I

1. (*a*) State and prove Gauss law. [6]

(*b*) The spherical region $0 < r < 10$ cm contains a uniform volume charge density $\rho_V = 4\mu C/m^3$. Find total charge for $0 < r < 10$ cm and flux density D just outside the region. [6]

(*c*) State and prove Divergence Theorem. [6]

P.T.O.

Or

2. (*a*) Find the flux density $(\overline{D})$ due to uniform line charge using Gauss law. [6]

(*b*) The spherical surfaces $r = 1$, 2 and 3 carry surface charge densities of 20, –9 and 2 nC/m^2 respectively.

(*i*) How much electric flux leaves the surface $r = 5$?

(*ii*) Find $\overline{D}$ at P(1, –1, 2). [6]

(*c*) An infinitely long, uniform, charge is located at $y = 3$, $z = 5$. If $\rho_L = 30$ nC/m, find E at :

(*i*) the origin

(*ii*) P_c (5, 6, 1). [6]

3. (*a*) Derive the expression for electric field and potential due to an electric dipole. [8]

(*b*) A parallel plate capacitor shown in the Figure 1 contains three dielectric layers as :

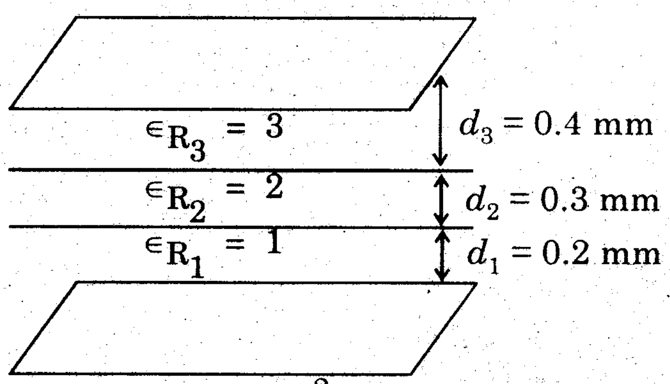

Fig. 1

Find (*a*) Capacitance C, (*b*) the percentage of total stored energy located in each of the three regions. [8]

Or

4. (*a*) Given the potential field $V = 10\, y(x^3 + 5)V$

(*i*) Find E at the surface $y = 0$.

(*ii*) Show that the surface $y = 0$ is an equipotential surface.

(*iii*) If it is known that the surface $y = 0$ is a conductor, find the total charge in the region $0 < x < 2$, $y = 0$, $0 < z < 1$. Assume that $\epsilon = \epsilon_0$ and that $V > 0$ in the region outside the conductor. [8]

(*b*) What is Laplace equation ? Derive expression for parallel plate capacitor using Laplace's equation. [8]

5. (*a*) Find the expression for $\overline{H}$ at any point in cylindrical coordinate system due to a filamentary conductor carrying a current I on the z-axis from $-\infty < z < \infty$ using Biot-Savart's Law. [8]

(*b*) Given points are A(1, 2, 4), B(–2, –1, 3) and C(3, 1, –2). Let the differential current element with I = 6 A and $|\overline{dL}| = 10^{-4}$ m is located at point A. The direction of $\overline{dL}$ is from A to B. Find $\overline{dH}$ at C. [8]

Or

6. (*a*) State and explain the Stokes' theorem. Also explain the physical significance of curl. [6]

(b) Find the vector magnetic field intensity in Cartesian coordinates at $P_2(1.5, 2, 3)$ caused by current filament of 24A in the a_z direction on the z-axis and extending from :

(i) $z = 0$ to $z = 6$

(ii) $z = 6$ to $z = +\infty$ [10]

SECTION II

7\. (a) Derive the boundary condition at an interface between two magnetic medium. [9]

(b) A unit vector directed from region 1 to region 2 at the planar boundary between two perfect dielectrics is given as :

$\bar{a}N_{12} = -(2/7)\bar{a}_x + (3/7)\bar{a}_y + (6/7)\bar{a}_z$. Assume $\epsilon_{R_1} = 3$, $\epsilon_{R_2} = 2$ and $\bar{E}_1 = 100\bar{a}_x + 80\bar{a}_y + 60\bar{a}_z$ V/m. Find $\bar{E}_2$. [9]

Or

8\. (a) Region 1 is the semi-infinite space in which $2x - 5y > 0$ while region 2 is defined by $2x - 5y < 0$. Let $\mu_{r_1} = 3$, $\mu_{r_2} = 4$ and $\bar{H}_1 = 30a_x$ A/m.

Find :

(i) $|\bar{B}_1|$

(ii) $|\overline{B_{N_1}}|$

(iii) $|\overline{H_{t_1}}|$

(iv) $|\bar{H}_2|$ [12]

(*b*) Derive the boundary condition for steady electric field at an interface between two perfect dielectric materials. [6]

9. (*a*) In a non-magnetic material ($\epsilon_R = 0$, $\mu = \mu_0$, $\sigma = 0$). Find η, electric field using Maxwell's equation and Poynting vector, given $\overline{H} = 30 \cos(2\pi \times 10^8 t - 6x)\overline{a}_y$. mA/m . [8]

(*b*) What is Poynting vector ? What is its significance ? Derive the expression for Poynting vector V. [8]

Or

10. (*a*) Write the Maxwell equation in point form and integral for time varying fields. [4]

(*b*) A point charge of 5 cos $10^{-7}\pi t$ μC is located at $P_1(0, 0, 5)$ while –5 cos $10^7\pi t$ μC is at P_2 (0, 0, –15) both in free space. Find potential at P(r = 3000, θ = 0°, ϕ = 0°) at t = 150 ns. [6]

(*c*) What is uniform plane wave ? What is meant by transverse electromagnetic wave ? [6]

11. (*a*) Explain the method of moments used to find solution of integral equation with suitable example. [10]

(*b*) Explain the procedure to draw electric field lines by numerical methods. [6]

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Or

12. (*a*) What is field plotting ? Explain procedure to draw equipotential lines. [6]

(*b*) Consider the potential system shown in Fig. 2 set the initial values at the free nodes equal to zero and calculate the potential at free nodes for four iterations using finite difference method. [10]

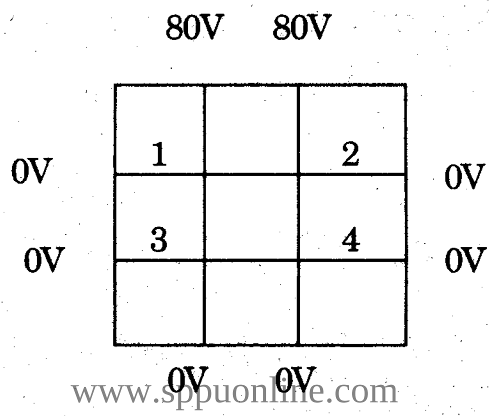

Fig. 2