GUJARAT TECHNOLOGICAL UNIVERSITY
BE- Vth SEMESTER-EXAMINATION – MAY/JUNE - 2012

Subject code: 151002
Date: 04/06/2012
Subject Name: Engineering Electromagnetics
Time: 02:30 pm – 05:00 pm
Total Marks: 70

Instructions:
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

Q.1 (a) Given points are E (2, 5, 1), F (-1, 4, -2) and G (3, -2, 4).
Find: (i) A unit vector directed from E towards F. (07)
(ii) The angle between $\mathbf{R}_{EF}$ and $\mathbf{R}_{EG}$. (07)
(iii) The scalar projection $\mathbf{R}_{EF}$ and $\mathbf{R}_{EG}$. (07)

(b) (i) Find the volume defined by $4 < \rho < 6$, $30^\circ < \phi < 60^\circ$, $2 < z < 5$. (07)
(ii) What is the length of the longest straight line that lies entirely within the volume? (07)
(iii) Find the total area of the surface. (07)

Q.2 (a) Find Electric field intensity due to infinite line with uniform line charge density $\rho_L$ on z-axis. (07)
(b) Find E at P (1, 5, 2) in free space if a point charge of 6 µC is located at Q(0, 0, 1), a uniform line charge $\rho_L=180$ nC/m lies along the z axis and a uniform sheet charge 25 nC/m$^2$ lies in the plane $z = -1$. (07)

OR
(b) Given the field $\mathbf{D}/\text{uni0305} = 6\rho \sin(\phi/2) \mathbf{\hat{a}}_\rho + 1.5\rho \cos(\phi/2) \mathbf{\hat{a}}_\phi \text{C/m}^2$. Evaluate both sides of the divergence theorem for the region bounded by $\rho = 2$, $0 < \phi < 180^\circ$, $0 < z < 5$. (07)

Q.3 (a) Derive equation to find Energy stored in the field of a system of charges. (07)
(b) The region $y < 0$ contains a dielectric material for which $\varepsilon_{R1}=2.5$, while the region $y > 0$ is characterized by $\varepsilon_{R2}=4$. Let $\mathbf{E}_1 = - 30 \mathbf{\hat{a}}_x + 50 \mathbf{\hat{a}}_y + 70 \mathbf{\hat{a}}_z \text{ V/m}$ Find (i) $\mathbf{D}_N$ (ii) $\mathbf{D}_{12}$ (iii) $\mathbf{D}_2$ (iv) $\theta_2$. (07)

OR
Q.3 (a) Find Capacitance between two concentric spheres using Laplace Equation. (07)
(b) Given a point of 200$\mu\varepsilon_0$ C at (3, -1, 2), a line charge of 40$\mu\varepsilon_0$ C/m on the x-axis and a surface charge of 8$\varepsilon_0$ C / m$^2$ on the plane $x = -3$, all in free space. Find the potential at P (5, 6, 7) if V = 0 at Q (0, 0, 1). (07)
Q.4 (a) Define the term “curl”. Also explain the point form of “Ampere’s circuital law”.

(b) Write the statement of Stoke’s theorem. Evaluate both sides of Stoke’s theorem for the field \( \vec{H} = 6xy \vec{a}_x - 3y^2 \vec{a}_y \text{ A/m} \) and the rectangular path around the region, \( 2 \leq x \leq 5, -1 \leq y \leq 1, \ z = 0 \). Let the positive direction of \( dS \) be \( \vec{a}_z \).

OR

Q.4 (a) Prove that for a differential current loop which carries current \( I \) in a given magnetic field, the torque on that loop is given by \( dT = d\vec{m} \times \vec{B} \).

(b) As shown in the figure below, the finite length current element is on the \( z \) – axis. Using Bio–savart law show that \( \vec{H} = I / 4\pi \rho (\sin \alpha_2 - \sin \alpha_1) \vec{a}_\rho \).  

\[ \begin{array}{c}
\text{Point 2} \\
\alpha_2 \\
\rho \\
\alpha_1 \\
\end{array} \]

Q.5 (a) Derive Maxwell’s four equations in point form.

(b) Explain Skin effect in detail. A steel pipe is constructed of a material for which \( \mu_r = 200 \) and \( \sigma = 5 \times 10^6 \text{ mho/m} \). The outer and inner radii 8 and 6 mm respectively and the length is 80 m. If the total current carried by the pipe is \( 2\cos10^4\pi t \text{ A} \), find (i) the skin depth (ii) the effective resistance.

OR

Q.5 (a) Derive Maxwell’s four equations in integral form.

(b) A lossy dielectric is characterized by \( \varepsilon_r = 2.5, \mu_r = 4, \) and \( \sigma = 10^{-3} \text{ mho/m at 10MHz} \). Let \( \vec{E}_s = 20\ e^{-yz} \vec{a}_x \text{ V/m} \) and find (i) \( \alpha \) (ii) \( \eta \) (iii) \( \vec{H}_s \).

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