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B. Tech
CPEE 5307

Sixth Semester Examination – 2008

ELECTROMAGNETIC THEORY

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory
and any **five** from the rest.

The figures in the right-hand margin
indicate marks.

1. Explain the following : 2×10
- (a) Can Stoke's theorem be applied to closed surfaces ?
 - (b) What is the significance of a zero vector ?
 - (c) What do we mean when we say that an object is charged ?
 - (d) Why is the electric field intensity not zero in a steady current carrying current ?

P.T.O.

- (e) When can we use Ampere's circuital law to determine the magnetic field ?
- (f) What is the significance of $\text{div. } (\mathbf{B})=0$?
- (g) What is meant by depth of penetration ?
- (h) Is it necessary for the fields to satisfy Maxwell's equations in order to exist ?
- (i) What is meant by a retarded field ?
- (j) What is a uniform linear array ?

2 (a) Using the rectangular coordinate system, verify that (i) $\text{div. } (\text{curl } \mathbf{A}) = 0$ (ii) $\text{curl } (\text{grad } f)$ 6

(b) Express the position vector $\mathbf{r} = x \mathbf{a}_x + y \mathbf{a}_y + z \mathbf{a}_z$ in the spherical coordinate system. 4

3. (a) Show that the equipotential surfaces for an infinite uniformly charged line are concentric cylinders. 4

(b) A long spherical cloud of radius 'b' has a uniform volume charge distribution of ρ_v .

Calculate and sketch the potential distribution and also electric field intensity at any point in space using Poisson's and Laplace's equation. 6

4. The conductivity of a homogeneous conducting medium, bounded by $10 \text{ cm} \leq r \leq 20 \text{ cm}$, $30^\circ \leq \theta \leq 45^\circ$ and $30^\circ \leq \varphi \leq 60^\circ$ is 0.4 S/m . The surface at $\theta = 45^\circ$ is at a ground potential, and the surface at $\theta = 30^\circ$ is at 100 V . Using Laplace's equation, determine the resistance of the medium, neglecting the edge effects. 10

5 (a) What do you mean by magnetic vector potential ? How is it different from magnetic scalar potential ? Can you derive the Biot-Savart law from the magnetic vector potential ? 5

(b) A straight wire extends from $z = -L$ to $z = L$ and carries a current I . What is the \mathbf{B} field in a plane bisecting the wire ? 5

6. State and explain the conditions of the electromagnetic fields at the interface between

- (a) dielectric – dielectric and
- (b) dielectric – conductor boundaries. 10

7. (a) Explain the polarization of a wave. What is the major difference between the elliptically and circularly polarized waves? 5

- (b) In a dielectric medium ($\epsilon = 9\epsilon_0$, $\mu = \mu_0$) a plane wave with $\mathbf{H} = 0.2 \cos(10^9 t - kx - k\sqrt{8} z) \mathbf{a}_y$ A/m is incident on an air boundary at $z = 0$, find (i) the incident E (ii) the transmitted and reflected E and (iii) k. 5

8. What is the difference between directive gain and directivity? Find the directive gain of the Hertzian dipole and compare with that of the half-wave dipole. 10

Extra Page
6th/8th Q paper
2/15/17