(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0324 Roll No. | | | | | | | | | | |

B. Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2010-11

ELECTROMAGNETIC FIELD THEORY

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **all** questions.

(2) All questions carry equal marks.

1. Attempt any **four** of the following : **(5×4=20)**

(a) Match the items in the left list with those in the right list. Each answer can be used once, more than once or not at all.

(i) $\theta = \pi/4$	(I) Infinite plane
(ii) $\phi = 2\pi/3$	(II) Semi infinite plane
(iii) $x = -10$	(III) Circle
(iv) $r = 1, \theta = \pi/3, \phi = \pi/2$	(IV) Straight line
(v) $\rho = 5$	(V) Semi circle
(vi) $\rho = 3, \phi = 5\pi/3$	(VI) Cone
(vii) $\rho = 10, z = 1$	(VII) Cylinder
(viii) $r = 4, \phi = \pi/6$	(VIII) Sphere
(ix) $r = 5, \theta = \pi/3$	(IX) Cube
	(X) Point

(b) Express the vector field :

$$\bar{H} = xy^2z\hat{a}_x + x^2yz\hat{a}_y + xyz^2\hat{a}_z$$

in cylindrical and spherical co-ordinates.

(c) Explain the significance of Del operator.

(d) Find the gradient of the following scalar field :

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

(ii) $v = 10r \sin^2\theta \cos\phi$.

(e) Find the Laplacian of the answer of problem (d).

(f) Let $\vec{D} = 2\rho z^2 a_\rho + \rho \cos^2 \phi a_z$. Evaluate :

(i) $\oint \vec{D} \cdot \vec{ds}$ and

(ii) $\int_V \nabla \cdot D dV$

over the region defined by $0 \le \rho \le 5, -1 \le z \le 1, 0 < \phi < 2\pi$.

2. Attempt any **four** of the following : **(5×4=20)**

(a) Explain and state Coulomb's law and its importance. Relate force with electric field intensity.

(b) Relate Electric field with Electric flux density. What is Gauss's law ? Apply it to find out $\vec{D}$ of infinite line charge.

(c) A circular disk of radius a is uniformly charged with ρ_s c/m². If the disk lies on the z = 0 plane with its axis along the z-axis show that at point (0, 0, h) :

$$\vec{E} = \frac{\rho_s}{2\varepsilon_0}\left\{1 - \frac{h}{[h^2 + a^2]^{1/2}}\right\}\hat{a}_z.$$

(d) Derive the electric field intensity at a distance r from an electric dipole.

(e) Explain the phenomenon of polarization in dielectric material. What is the significance of Linear, Isotropic and homogeneous dielectrics ?

(f) Determine the capacitance of each of the capacitors in figure 1. Consider $\varepsilon_{r_1} = 4, \varepsilon_{r_2} = 6$, d = 2 mm, s = 20 cm².

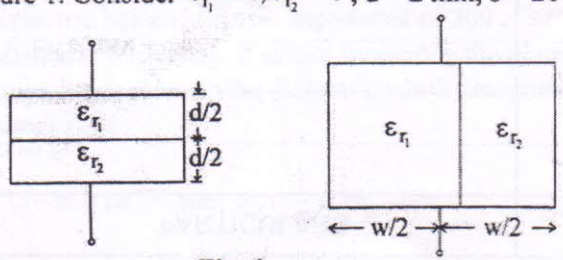

Fig. 1

3. Attempt any **two** of the following : **(10×2=20)**

(a) (i) The conducting triangular loop in Fig. 2 carries a current of 10 A. Find $\bar{H}$ at (0, 0, 5) due to side 1 of the loop.

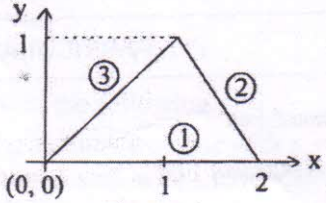

Fig. 2

(ii) State and prove Ampere's circuital law and derive Maxwell's equation from it.

(b) Discuss and derive Magnetic scalar and vector potentials. Given the magnetic vector potential $\bar{A} = -\rho^2/4\, a_z$ wb/m, calculate the total magnetic flux crossing the surface :

$\phi = \pi/2,\ 1 \le \rho \le 2$ m, $0 \le z \le 5$ m.

(c) State and derive magnetic boundary conditions. Calculate the self inductance per unit length of an infinitely long solenoid.

4. Attempt any **two** of the following : **(10×2=20)**

(a) State and write Maxwell's equation in integral and differential form. What do you mean by lossy Dielectric and derive the wave equation in lossy dielectric.

(b) What is skin depth and discuss its significance. A lossy dielectric has an intrinsic impedance of $200 \angle 30°\ \Omega$ at a particular frequency. If at that frequency the plane wave propagating through the dielectric has the magnetic field component :

$$\bar{H} = 10^{-\alpha x} \cos\left(wt - \frac{1}{2}x\right)\hat{a}_y \text{ A/m.}$$

Find E and α. Determine Skin Depth also.

(c) In free space ($z \leq 0$), a plane wave with :

$$\vec{H} = 10 \cos (10^8 t - \beta z) a_x \text{ mA/m}$$

is incident normally on a lossless medium ($\varepsilon = 2\varepsilon_0, \mu = 8\mu_0$) in region $z \geq 0$. Determine the reflected wave $\vec{H}_r, \vec{E}_r$ and the transmitted wave $\vec{H}_t, \vec{E}_t$.

5. Attempt any **two** of the following : **(10×2=20)**

(a) A 30 m long transmission line with $z_0 = 50\ \Omega$ operating at 2 MHz is terminated with a load $z_L = 60 + j40\ \Omega$. If the velocity of wave $v = \cdot 6C$ on the line find the reflection coeff. Γ, the standing wave ratio, and the input impedance.

(b) Explain the role of Smith Chart in measurement of various parameters in Transmission line.

(c) Derive transmission line voltage and current equations. Discuss the concept of Distortionless and lossless line.