(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 2013-14

ELECTROMAGNETIC FIELD THEORY

Time : 3 Hours *Total Marks : 100*

Note :– Attempt **all** the questions. All questions carry equal marks.

1. Attempt any **four** parts : **(5×4=20)**

(a) Given $\overline{A} = 2a_x + 4a_y$ and $\overline{B} = 6a_y - 6a_z$, find the smaller angle between them using

(i) the cross product

(ii) the dot product.

(b) Transform :

$$\overline{A} = ya_x + xa_y + \frac{x^2}{\sqrt{x^2 + y^2}} a_z$$

from Cartesian to Cylindrical coordinates.

(c) If $\overline{A} = 10a_x - 4a_y + 6a_z$ and $\overline{B} = 2a_x + a_y$, find :

(i) the component of $\overline{A}$ along a_y

(ii) the magnitude of $3\overline{A} - \overline{B}$

(iii) a unit vector along $\overline{A} + 2\overline{B}$.

(d) State and explain the divergence theorem.

(e) Find the Laplacian of the scalar fields :

(i) $V = e^{-z} \sin 2x \cos h\, y$

(ii) $U = P^2 z \cos 2\phi$

(f) Define :

(i) Line charge

(ii) Conduction current

(iii) Gauss law.

2. Attempt any **four** parts : **(5×4=20)**

(a) A charge $Q_1 = -10$ nc is at the origin in free space. If the x-component of E is to be zero, at the point (3, 1, 1), what charge Q_t should be kept at the point (2, 0, 0) ?

(b) Determine the force on a point charge of 5 nc at (0, 0, 5) m due to uniformly distributed charge of 5 mc over a circular disc of radius $r \leq 1$m in $z = 0$ plane.

(c) An electric field is given by $E = 10\, y\, a_x + 10\, x\, a_y$, v/m. Find the potential function, V. Assume $V = 0$ at the origin.

(d) Prove that the net flux passing through any closed surface is equal to the charge enclosed by that surface.

(e) If the current density, $J = \frac{1}{r^2}(\cos\theta\, a_r + \sin\theta\, a_\theta)$, A/m².

Find the current passing through a sphere radius of 1.0 m.

(f) The cable shown in Fig (a) is 10 km long. If $r_1 = 10$ mm, $r_2 = 15$ mm, $r_3 = 20$ mm, $\epsilon r_1 = 2.0$, $\epsilon r_2 = 3.0$, find the capacitance of the cable.

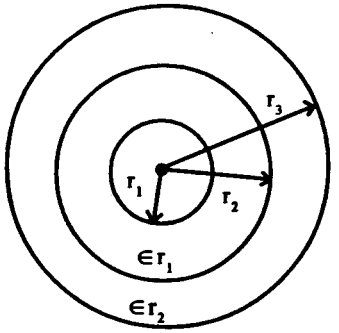

Fig. (a)

3. Attempt any **two** parts : **(10×2=20)**

(a) A small current loop L_1 with magnetic moment $5a_z$ A/m² is located at the origin. While another small loop current L_2 with magnetic moment $3a_y$ A·m² is located at (4, –3, 10). Determine the torque on L_2.

(b) State and explain the Biot-Savart's law.

(c) Determine the magnetic field intensity, H at the centre of a square current element. The length of each side is 2 m and the current, I = 1.0 Amp.

4. Attempt any **two** parts : **(10×2=20)**

(a) State and explain the Maxwell's equation in differential and integral form. Also explain from which laws they are derived.

(b) The electric field in free space is given by
$E = 50 \cos(10^8 t + \beta x)\, a_y$ V/m.

(i) Find the direction of wave propagation.

(ii) Calculate β and the time it takes to travel a distance of $\lambda/2$.

(iii) Sketch the wave at t = 0, T/4 and T/2.

(c) Explain the reflection of a plane wave at oblique incidence. Calculate reflection and transmission coeff.

5. Attempt any **two** parts : **(10×2=20)**

(a) A certain transmission line operating at $w = 10^6$ rad/s has $\alpha = 8$ db/m, $\beta = 1$ rad/m and $Z_0 = 60 + j\,40\Omega$ and is 2 m long. If the line is connected to a source of $10 < 0^0$ V, $Z_g = 40\ \Omega$ and terminated by a load of $20 + j50$ ohm, determine :

(i) the input impedance

(ii) the sending-end current

(iii) the current at the middle of the line.

(b) (i) What is Smith Chart ? Explain how it is constructed.

(ii) Using Smith Chart, find the input impedance of 75Ω loss less transmission line of length 0.1λ when the load is a short.

(c) A transmission line of length $0.40\ \lambda$ has a characteristic impedance of $100\ \Omega$ and is terminated in a load impedance of $200 + j\ 180\ \Omega$. Find the —

(i) Voltage reflection coefficient

(ii) Voltage standing wave ratio

(iii) Input impedance of the line.