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

PAPER ID : 130402 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. IV) THEORY EXAMINATION 2013-14

ELECTROMAGNETIC FIELD THEORY

Time : 3 Hours *Total Marks : 100*

Note :– Attempt **all** Sections.

SECTION–A

1. Attempt **all** parts : **(10×2=20)**

(a) What do you mean by gradient of a scalar ? Write its expression in all co-ordinate systems.

(b) Prove that the divergence of the curl of a vector field vanishes.

(c) Define Gauss's law. What do you mean by Gaussian surface?

(d) What do you mean by conservative fields ?

(e) Define Polarization in dielectric materials.

(f) Write the Maxwell's equations in integral & differential form.

(g) What do you mean by Mutual & Self indcutances ?

(h) A plane wave in a nonmagnetic medium has $\bar{E} = 50\sin(10^8 t + 2z)\hat{a}_y$ V/m. Find d, f, e_r.

(i) Differentiate between lumped and distributed components.

(j) Write the condition for distortionless transmission line.

SECTION–B

2. Attempt any **three** parts : **(10×3=30)**

(a) Determine the flux of $\overline{D} = \rho^2 \cos 2\phi \, \hat{a}_\rho + 2 \sin \phi \, \hat{a}_\rho$ over the closed surface of the cylinder $0 \leq z \leq 1$, $\rho=4$. Verify the divergence theorem for this case.

(b) Given that $\overline{E} = (3x^2 + y)\,\hat{a}_x + x\,\hat{a}_y$ kV/m. Find the work done in moving a -2μc charge from (0,5,0) to (2,-1,0) by taking the straight line path as :

(i) $(0,5,0) \rightarrow (2,5,0) \rightarrow (2,-1,0)$

(ii) $y = 5-3x$.

(c) Determine the self-inductance of coaxial cable of inner radius a and outer radius b.

(d) What do you mean by intrinsic impedance of a medium ? Derive intrinsic impedance for plane waves in lossless dielectrics.

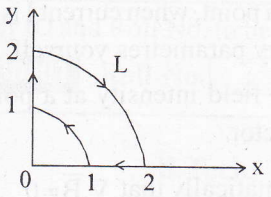
(e) Derive the equation for a two conductor transmission line in terms of V and I.

SECTION–C

3. Attempt any **two** parts : **(5×10=50)**

(a) Write the statement of divergence theorem. Prove the divergence theorem and also write the physical significance of divergence.

(b) Let $\overline{A} = \rho \sin \phi \, \hat{a}_\rho + \rho^2 \hat{a}_\phi$ Verify the Stokes theorem for the given contour.



(c) Express the vector $\overline{B} = \frac{10}{r} \hat{a}_r + r \cos\theta \hat{a}_\phi + \hat{a}_\phi$ in Cartesian coordinate system.

4. Attempt any **two** parts :

(a) Point charges $Q_1 = 1nc$, $Q_2 = -2nc$, $Q_3 = 3nc$ and $Q_4 = -4nc$ are positioned one at a time in that order at (0,0,0), (1,0,0), (0,0,-1) and (0,0,1) respectively. Calculate the energy in the system after each charge is positioned.

(b) Three identical small spheres of mass m are suspended from a common point by threads of negligible masses and equal lenghts l. A charge Q is divided equally among the spheres, and they come to equilibrium at the corners of a horizontal equilateral triangle whose sides are d. Show that

$$Q^2 = 12 \pi \varepsilon_o \, mgd^3 \left[l^2 - \frac{d^2}{3}\right]^{\frac{-1}{2}}$$

Where g =acceleration due to gravity.

(c) Derive the electric field for each possible case due to an uniformily charged sphere of radius R and volume charge density ρ.

5. Attempt any **two** parts :

(a) Derive the magnetic field intensity due to a finite length conductor at a point, when current I is flowing in it. Assume the neccessary parametres yourself. Therefore determine the magnetic field intensity at a point due to an infinite length conductor.

(b) Show mathematically that $\nabla.\overline{B}=0$

(c) A charged particle of mass 1 kg. and charge 2 c. starts at origin with zero initial velocity in a region where $\overline{E}=3\hat{a}_z$ v/m
Find the following :

(i) The force on the particle.

(ii) The time it takes to reach point P (0,0,12)

(iii) Its velocity and acceleration at P.

(iv) Its K.E. (kinetic energy) at P.

6. Attempt any **two** parts :

(a) At 50 MHz, a lossy dielectric material is characterized by, $\epsilon = 3.6\ \epsilon_o$ $\mu = 2.1\ \mu_o$ and $\sigma = 0.08$ s/m. If $E_s - 6e^{-\pi x}\ \hat{a}_z$ V/m. Compute (a) γ (b) λ (c) η (d) H_s

(b) Define and derive skin depth for conductors.

(c) State and derive Poynting's theorem.

7. Attempt any **two** parts :

(a) A transmission line operating at 500 MHz has $z_o = 80\ \Omega$, $\alpha = 0.04$ NP/m, $\beta = 1.5$ rad/m.
Find the line parameters R, L, G, C.

(b) Derive the input impedance, standing wave ratio and voltage reflection coefficient of a two conductor transmission line.

(c) Why do we need impedance matching in transmission line ? Also discuss the various methods of impedance matching.