

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

**PAPER ID : 0324**

Roll No.

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**B.Tech.**

(SEM. III) THEORY EXAMINATION 2011-12  
**ELECTROMAGNETIC FIELD THEORY**

*Time : 3 Hours**Total Marks : 100***Note :-** (1) All questions carry equal marks.(2) Attempt **all** questions.

- I. Attempt any **four** parts of the following : **(5×4=20)**
- (a) Given vector field  $G = 8 \sin \phi \mathbf{a}_r$  in spherical coordinate  
 Transform it into :
- (i) Rectangular Coordinate  
 (ii) Cylindrical Coordinate
- (b) Find the gradient of the following scalar field
- (i)  $V = e^z \sin 2x \cosh y$   
 (ii)  $U = P^2 Z \cos 2\phi$
- (c) Derive expression for electric field due to infinitely long wire.
- (d) Write down the expression/statement of the :
- (i) Maxwell's curl equation for time varying field.  
 (ii) Differential form of Ampere's law.

(e) Given a vector function :

$$\vec{A} = (3x+4z) \vec{a}_x + (c_2x-5z) \vec{a}_y + (4x-c_3y+c_4z) \vec{a}_z$$

Calculate  $c_1, c_2, c_3, c_4$  if  $\vec{A}$  is irrotational and solenoidal.

(f) A charge distribution with spherical symmetry has density

$\rho_v = \rho_0 r/R, 0 \leq r \leq R$  and 0 for  $r > R$ , Determine  $E$  everywhere.

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

(a) Derive Energy density in electrostatic field. A sphere of volume  $0.1 \text{ m}^3$  has a charge density of  $8.0 \text{ pc/m}^3$ . Find the electric field at a point  $(2,0,0)$  if the centre of the sphere is at  $(0,0,0)$ .

(b) State and explain the Coulomb's law. If the current density  $J=1/r^2 (\cos \theta \vec{a}_r + \sin \theta \vec{a}_\theta)$ .  $\text{A/m}^2$ , find the current passing through a sphere of radius  $1.0 \text{ m}$ .

(c) Discuss the relevance of uniqueness theorem. A spherical condenser has capacity of  $54 \text{ pF}$ . It consist of two concentric sphere differing in radius by  $4 \text{ cm}$  and having an air as dielectric. Find their radii.

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

(a) Write down the boundary condition for current density and postulates of Magnetostatics in free space.

(b) Prove that  $B = (\mu_0 I_b^2/4R^3) (\vec{a}_R \cos \theta + \vec{a}_\theta \sin \theta)$  for magnetic dipole.

- (c) Given that  $H_1 = -2a_x + 6a_y + 4a_z$  A/m in region  $y-x-2 \leq 0$  where  $\mu_1 = 5\mu_0$  calculate  $M_1$  and  $B_1$ .
- (d) Find inductance of coaxial cable.
- (e) Explain the relevance of Magnetic scalar and vector potential.
- (f) In a material for which  $\sigma = 5$  S/m and  $\epsilon_r = 1$ , the electrical field intensity is  $E = 250 \sin 10^{10}t$  V/m. Find conduction and displacement current densities and the frequency at which both have equal magnitude.

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

- (a) Derive the expression for  $\alpha$  and  $\beta$  in a conducting medium. Explain skin effect and depth of penetration.
- (b) Derive the wave equation for conducting media. A uniform plane wave is propagating in the +z direction in a good conductor having conductivity  $\sigma$  S/m. The permittivity and permeability in the conductor are the same as in free space and the electric field is  $x E_0$  at  $z = 0$ . What power ( $W/m^2$ ) is dissipated in this medium for  $z > 0$ ? Assume  $\sigma \gg \omega\epsilon$ .
- (c) Derive Faraday law of induction. Explain the concept of Transformer and motional electromotive force. Discuss the relevance of Anisotropic media.

5. Attempt any **two** parts of the following : **(10×2=20)**
- (a) Discuss the structure of Smith Chart. How it is used for measurement of impedances and VSWR ?
- (b) Relate short circuit, open circuit and characteristic impedance of Transmission line. The short circuit and open circuit impedance of 10 km long open wire transmission line are  $Z_{sc} = 2930 \angle 26^\circ$  and  $Z_{oc} = 260 \angle -32^\circ$  at a frequency of 1 kHz. Calculate the characteristics impedance and phase velocity.
- (c) Define reflection loss, transmission loss and return loss. The  $600 \Omega$  lossless transmission line is fed by  $50 \Omega$  generator. If the line is 200 meter long and terminated by load  $500 \Omega$ . Determine in db
- Reflection loss
  - Transmission loss
  - Return loss.