

(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.

1. 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 m^3 has a charge density of 8.0 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 $J=1/r^2 (\cos \theta \vec{a}_r + \sin \theta \vec{a}_\theta)$. A/m^2 , find the current passing through a sphere of radius 1.0 m .

- (c) Discuss the relevance of uniqueness theorem. A spherical condenser has capacity of 54 pF . It consist of two concentric sphere differing in radius by 4 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 $B = (\mu_0 I_b^2/4R^3) (a_R^2 \cos \theta + a_\theta \sin \theta)$ 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 α and β 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 σ 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 600Ω lossless transmission line is fed by 50Ω generator. If the line is 200 meter long and terminated by load 500Ω . Determine in db
- (i) Reflection loss
 - (ii) Transmission loss
 - (iii) Return loss.