

(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) ODD SEMESTER THEORY EXAMINATION 2012-13

ELECTROMAGNETIC FIELD THEORY

Time : 3 Hours

Total Marks : 100

Note : Attempt *all* the questions.1. Answer any **four** parts :(a) If $\vec{A} = 3a_r + 2a_\theta - 6a_\phi$ and $B = 4a_r + 3a_\phi$. Determine :

(i) $\vec{A} \cdot \vec{B}$

(ii) $|\vec{A} \times \vec{B}|$

(b) Prove that the total outward flux of a vector field $\vec{A}$ through the closed surfaces S is the same as the volume integral of the divergence of $\vec{A}$.(c) Evaluate $\nabla \times \vec{A}$ and $\nabla \cdot \nabla \times \vec{A}$, if

$$\vec{A} = x^2y a_x + y^2z a_y - 2xz a_z.$$

(d) Prove that :

$$\nabla \cdot (\vec{V}\vec{A}) = \vec{V}\nabla \cdot \vec{A} + \vec{A} \cdot \nabla \vec{V}$$

where V is a scalar field and A is a vector field.(e) If $U = xz - x^2y + y^2z^2$ evaluate $\text{div grad } U$.

(f) Explain Stoke's theorem.

2. Answer any **four** parts :

(a) Explain Coulomb's law and field intensity.

- (b) Define Electric potential.
- (c) If $\mathbf{J} = \frac{1}{r^3} (2 \cos \theta \mathbf{a}_r + \sin \theta \mathbf{a}_\theta) \text{ A/m}^2$. Calculate the current passing through a hemisphere shell of radius 20 cm.
- (d) A wire of diameter 1 mm and conductivity $5 \times 10^7 \text{ S/m}$ has 10^{29} free electrons/ m^3 when an electric field of 10 mV/m is applied. Determine :
 - (i) The current density
 - (ii) The current in the wire
 - (iii) The charge density of free electrons.
- (e) Explain Dielectric Boundary conditions.
- (f) Explain Free-space Boundary condition.

3. Answer any **two** parts :

- (a) Given the magnetic vector potential $\mathbf{A} = -\rho^2/4 \mathbf{a}_z \text{ Wb/m}$, calculate the total magnetic flux crossing the surface $\phi = \pi/2$, $1 \leq \rho \leq 2 \text{ m}$, $0 \leq z \leq 5 \text{ m}$.
- (b) Explain magnetic boundary conditions.
- (c) A charged particle moves with a uniform velocity $4 \mathbf{a}_x \text{ m/s}$ in a region where $\mathbf{E} = 20 \mathbf{a}_y \text{ V/m}$ and $\mathbf{B} = B_0 \mathbf{a}_z \text{ Wb/m}^2$. Determine B_0 such that the velocity of the particle remains constant.

4. Answer any **two** parts :

- (a) Prove that the net power flowing out of a given volume V is equal to the time rate of decrease in energy stored within volume V minus the conduction losses.

- (b) A parallel plate capacitor with a plate area of 5 cm^2 and plate separation of 3 mm has a voltage $50 \sin 10^3 t \text{ V}$ applied to its plates. Calculate the displacement current assuming $\epsilon = 4 \epsilon_0$.
- (c) In a free space $H = 0.2 \cos (wt - Bx) a_z \text{ A/m}$. Find the total power passing :
- (i) A square plate of side 10 cm on plane $x + z = 1$.
- (ii) A circular disc of radius 5 cm on plane $x = 1$.

5. Answer any **two** parts :

- (a) Find the input impedance of 75Ω lossless transmission line of length 0.1λ when the load is short by using Smith chart.
- (b) Derive the relation between reflection coefficient and voltage standing wave ratio (VSWR). Explain what will be the input impedance of transmission line when output impedance is short.
- (c) A lossless transmission line used in a TV receiver has a capacitance of 50 PF/m and an inductance of 200 nH/m . Find the characteristics impedance for sections of a line 10 meter long and 500 meter long.