



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

**PAPER ID : 3081**

Roll No.

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**B. Tech.****(SEM. IV) EXAMINATION, 2008-09****ELECTROMAGNETIC FIELD THEORY***Time : 3 Hours]**[Total Marks : 100*

- Note :**
- (1) Attempt **all** the questions.
  - (2) **All** the questions carry **equal** marks.

1 Attempt any **two** parts of the following :

- (a) Establish the following vector identities :
- 6+4**

$$(i) \quad \vec{A} \times (\vec{B} \times \vec{C}) = (\vec{A} \cdot \vec{C}) \vec{B} - (\vec{A} \cdot \vec{B}) \vec{C}$$

$$(ii) \quad \nabla \cdot (\nabla \times \vec{A}) = 0$$

- (b) Discuss the following terms as applied
- 3+3+4**
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- to vector fields :

- (i) Gradient
- (ii) Divergence
- (iii) Curl and its physical interpretation

- (c) Find the divergence of the vector function
- 5+5**

$$\vec{A} = x^2 \vec{x} + (xy)^2 \vec{y} + 24(xyz)^2 \vec{z}$$

Evaluate the volume integral of  $\nabla \cdot \vec{A}$  through the volume of a unit cube centered at the origin.



- 2 Attempt any **two** parts of the following :
- (a) (i) Show that the capacitance of a parallel plate capacitor is given by  $C = \frac{\epsilon A}{d}$  4  
 where  $\epsilon$  is the permittivity of the dielectric in between the plates,  $A$  is the surface-area of the plates, and  $d$  is the distance between the plates of the capacitor.
- (ii) Derive an expression for the capacitance per unit length of a coaxial cable with permittivity  $\epsilon$ , inner diameter  $d$  and outer diameter  $D$ . 6
- (b) State and explain *Gauss's Law*. Derive an expression for the potential at a point outside a hollow sphere having a uniform charge density. 4+6
- (c) Define the following terms with suitable examples : 2×5
- (i) The *dielectric* material
  - (ii) The *conductors*
  - (iii) The *homogeneous* medium
  - (iv) The *linear medium*
  - (v) The *isotropic medium*

- 3 Attempt any **two** parts of the following : 10×2=20
- (a) (i) State and explain *Ampere's circuital law* in integral form. 4
- (ii) Derive an expression for the force between two parallel wires carrying currents in the same direction. 6
- (b) Derive Maxwell's first and second equations in integral and differential forms. 10
- (c) Define and explain the terms magnetic force, magnetic flux density and magnetic permeability and the units in which each of these quantities is measured in the MKS unit. 10



4 Attempt any **two** parts of the following :

- (a) Show that the propagation constant of a plane wave in the conducting medium can be given by 10

$$\gamma = \left[ \omega \sqrt{\frac{\mu\epsilon}{2} \left( \sqrt{1 + \left(\frac{\sigma}{\omega\epsilon}\right)^2} - 1 \right)} \right] + j \left[ \omega \sqrt{\frac{\mu\epsilon}{2} \left( \sqrt{1 + \left(\frac{\sigma}{\omega\epsilon}\right)^2} + 1 \right)} \right]$$

where the parameters have their usual meaning.

- (b) Consider the reflection phenomenon of a plane wave travelling through a medium of permittivity  $\epsilon_1$  and permeability  $\mu_1$  is incident normally to the surface of a perfect dielectric medium with permittivity  $\epsilon_2$  and permeability  $\mu_2$ . Derive the expressions for the reflection and transmission coefficients for the electric and magnetic fields. 10

- (c) (i) What do you mean by the *surface impedance* of a conductor ? 3

- (ii) A thick brass plate is plated with a 0.005-inch thickness of silver. What is the surface impedance at 10 MHz ? Compare the surface impedance of the plated brass with that of a solid silver plate and a solid brass plate. Derive the necessary formula to be used for your calculations. 7

Assume  $\sigma = 6.2 \times 10^7$  mhos/m for silver,

$\sigma = 1.0 \times 10^7$  mhos/m for brass,  $\mu = \mu_v$

and  $\epsilon = \epsilon_v$  where  $\mu_v$  and  $\epsilon_v$  are the permeability and permittivity of the vacuum respectively.



5 Attempt any **two** parts of the following :

- (a) Define the terms and obtain expression for the voltage wave standing wave ratio, reflection coefficient and reflection percentage on a loss free transmission line having mismatch. **10**
- (b) Show that the input impedance of a transmission line is given by **10**

$$Z_{in} = Z_0 \frac{Z_r \cosh(\gamma d) + jZ_0 \sinh(\gamma d)}{Z_0 \cosh(\gamma d) + jZ_r \sinh(\gamma d)}$$

where  $Z_0$  is the characteristic impedance,  $Z_r$  is the terminating impedance of the line,  $\gamma$  is the propagation constant and  $d$  is the length of the line.

- (c) Consider two parallel perfectly conducting planes at  $x = 0$  and  $x = a$ . Derive an expression for the attenuation factor for the TEM waves. **10**
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