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Printed Pages : 4 **TEC – 401**

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

PAPER ID : 3081 Roll No.

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) $$\vec{A}\times\left(\vec{B}\times\vec{C}\right)=\left(\vec{A}\cdot\vec{C}\right)\vec{B}-\left(\vec{A}\cdot\vec{B}\right)\vec{C}$$

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

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

(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 $C = \frac{\varepsilon A}{d}$ where ε 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. **4**

(ii) Derive an expression for the capacitance per unit length of a coaxial cable with permittivity ε, 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.

(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**

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

where the parameters have their usual meaning.

(b) Consider the reflection phenomenon of a plane wave travelling through a medium of permittivity ε_1 and permeability μ_1 is incident normally to the surface of a perfect dielectric medium with permittivity ε_2 and permeability μ_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. Assume $\sigma = \mathbf{6.2 \times 10^7}$ mhos/m for silver, $\sigma = \mathbf{1.0 \times 10^7}$ mhos/m for brass, $\mu = \mu_v$ and $\varepsilon = \varepsilon_v$ where μ_v and ε_v are the permeability and permittivity of the vacuum respectively. **7**

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, γ 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**