Printed Pages – 5 **TEC – 401**

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

PAPER ID : 3081 **Roll No.**

B.Tech.

FOURTH SEMESTER EXAMINATION, 2005-2006

ELECTROMAGNETIC FIELD THEORY

Time : 3 Hours *Total Marks : 100*

Note : *(i) Attempt **ALL** questions.*
(ii) All questions carry equal marks.
(iii) In case of numerical problems assume data wherever not provided.
(iv) Be precise in your answer.

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1. Attempt ***any four*** parts of the following : **(5x4=20)**

(a) Verify that vector field $\vec{A}=yz\,\vec{I}x+zx\,\vec{I}y+xy\,\vec{I}z$ is irrotational and solenoidal.

(b) If Q_1, Q_2 are charges located at distances r_1, r_2, ... from the point P, then the electric - intensity $\vec{E}$ at point P will be :

$$\vec{E}=\frac{1}{4\pi\epsilon}\sum_{i=1}^{i=n}(Q_i/r_i^2)\hat{I}r_i$$

(c) An infinite sheet with surface charge $Q=12\epsilon_o\ cm^{-2}$ is lying in the plane $x-2y+3z=4$. Find an expression for the field-intensity on the side of the plane containing the origin.

(d) Two charges of opposite sign and magnitude 1 $\mu\mu$C are located 1 m apart. Find the potential at a point located midway between the two charges and 50 cm from the line connecting the charges. What shall be potential if the charges have similar sign ?

(e) A total charge of 10^{-8} C is distributed uniformly along a ring of radius 5 m. Calculate the potential on the axis of the ring at a point 5 m from the centre of the ring. If the same charge is uniformly distributed on a disc of 5 m radius, what will be the potential on its axis at 5 m from the centre ?

(f) Relate Electric flux ψ_e and Electric flux density $\vec{D}$ with Electric Field $\vec{E}$. Three point charges are located in air : +0.008 μc at (0, 0)m, +0.005 μc at (3, 0) m, and at (0, 4) m there is a charge of −0.009μc. Compute total flux over a sphere of 5 m radius with centre (0, 0)

2. Attempt ***any two*** parts of the following : **(10x2=20)**

(a) A capacitor of two large horizontal parallel plates has an internal separation 'd' between plates. A dielectric slab of relative permittivity ϵ_r and thickness a is placed on the lower plate of capacitor. Neglect edge effects. If the potential difference between the plates is ϕ, show that the electric - field intensity E_1 in the dielectric is $E_1 = \frac{\phi}{\epsilon_r\, d.a\,(\epsilon_r - 1)}$ and capacitance C of the arrangement will be :

$$\frac{\epsilon_o A}{d}\left[\frac{\epsilon_r}{\left(1-\frac{a}{d}\right)\epsilon_r+\frac{a}{d}}\right]$$ where A → Area of the plate.

(b) Determine the energy stored in the electric field in a concentric spherical shell.

(c) Calculate the potential at any point between two grounded semi-infinite parallel electrodes separated by a distance 'b' and a plane electrode at potential Vo.

3. Attempt *any two* parts of the following : **(10x2=20)**

(a) A No 10 copper wire carries a conduction current of 1 amp at 60Hz. What is the displacement current in the wire ? For copper assume

$$\epsilon=\epsilon_o = \underset{\text{farad/meter}}{\frac{1}{36\pi}\times 10^9}, \quad \mu=\mu_o = \underset{\text{henry/m}}{4\pi\times 10^{-7}}, \quad \sigma = 5.8\times 10^7 \text{℧/m}$$

(b) Discuss wave propagation in Good Dielectrics and Good conductors. Show that angle of characteristic impedance is always 45° for good conductors.

(c) A current sheet with surface current density k is given by $\vec{k}=k.\hat{1}_z\ Am^{-1}$ where k is a constant coincides with the *xz* plane as shown in fig (c). Find a general relation for flux - density.

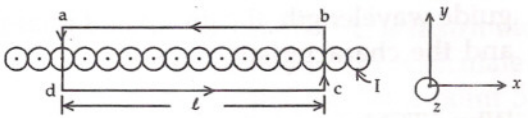

Fig - (c)

4. Attempt ***any two*** parts of the following : **(10x2=20)**

(a) Discuss reflection of plane electromagnetic wave incident normally on a perfect dielectric and obtain expressions for the two reflection coefficients of Electric and Magnetic fields.

(b) Find α, β, γ, λ, ν and η for damp soil at 10^6Hz given that for damp soil $\epsilon_r=12$, $\sigma=2\times10^{-2}$ $\mho/m$, $\mu_r=1$. The symbols carry their usual meaning.

(c) A 10 GHz plane wave travelling in free space has an amplitude $Ex=10$ v/m. Find :

(i) Phase velocity, wavelength and propagation constant.

(ii) Characteristic Impedance of Medium.

(iii) Amplitude and direction of the magnetic - filed intensity.

5. Attempt *any two* parts of the following : **(10x2=20)**

(a) Find cut off wavelength, for the dominant mode, in a rectangular waveguide whose breadth is 10 cm. For a 2.5 GHz signal propagated in this waveguide in the dominant mode, calculate the guide wavelength, the group and phase velocities and the characteristic impedance.

(b) Why a TEM wave fails to propagate within a single conductor waveguide ? Which factors decide selection of waveguide and its dimensions ?

(c) Find at what transmission both TE and TM modes are possible at 3 GHz in a hollow rectangular waveguide of inner dimensions 6 cm × 4 cm. Find phase constant, phase velocity and group velocity for any mode which can be propagated.

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