



Printed Pages : 4

TEC – 401

(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, 2006-07

ELECTRO MAGNETIC FIELD THEORY

Time : 3 Hours]

[Total Marks : 100

Note : Attempt *all* the questions.

- 1 Attempt any **four** of the following :
- (a) Write down gradient of any scalar and divergence and curl of any vector. \vec{A} in different co-ordinate system. **5**
- (b) If $\vec{A} = \alpha \hat{a}_x + 2\hat{a}_y + 10\hat{a}_z$ and $\vec{B} = 4\alpha \hat{a}_x + 8\hat{a}_y - 2\alpha \hat{a}_z$ find out the value of α for which the two vectors become perpendicular. **5**
- (c) Given points $A(x = 2, y = 3, z = -1)$ and $B(\rho = 4, \phi = -50^\circ, z = 2)$ find the distance A to B . **5**
- (d) State the word statement of Coulomb's law of forces. Three point charges $q_1 = 10^{-6}C$, $q_2 = -10^{-6}C$ and $q_3 = 0.5 \times 10^{-6}C$ are located in air at the corners of an equilateral triangle of 50 cm side. Determine the magnitude and direction of the force of q_3 . **5**

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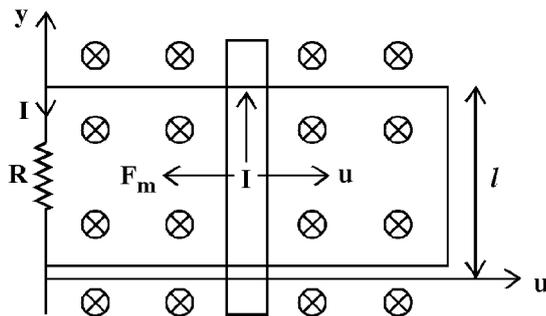
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- (e) Two uniform line charges of density $\rho_e = 4 \text{ nc/m}$ lie in the $x = 0$ plane at $y = 4 \text{ m}$. Find \vec{E} at $(4, 0, 10) \text{ m}$. 5
- (f) Charge distributed throughout a volume V with density ρ gives rise to an electric field with energy content $W_E = \frac{1}{2} \int_V \rho V dV$. Show that its equivalent is $W_E = \frac{1}{2} \int \epsilon E^2 dV$ where ϵ is permittivity of the medium. 5

- 2 Attempt any four of the following :
- (a) Explain convection current and conduction current. Derive ohm's law in point form. 5
- (b) The electric field intensity in polystyrene ($\epsilon_r = 2.55$) filling the space between the plates of a parallel plate capacitor is 10 kV/m . The distance between the plates is 1.5 mm . Calculate : (i) The surface charge density of free charge on the plates (ii) The potential difference between the plates. 5
- (c) Derive dielectric - dielectric boundary conditions. 5
- (d) Two conducting cones ($\theta = \pi/10$ and $\theta = \pi/6$) of infinite extent are separated by an infinitesimal gap $r = 0$. If $V(\theta = \pi/10) = 0$ and $V(\theta = \pi/6) = 50 \text{ V}$ find V and E between the cones. 5
- (e) The electric field intensity at a point on the surface of a conductor is given by $\vec{E} = 0.2 \hat{a}_x - 0.3 \hat{a}_y - 0.2 \hat{a}_z \text{ V/m}$. Find the surface charge density at that point. 5
- (f) Determine \vec{E} in spherical co-ordinates from Poisson's equation, assuming a uniform charge density ρ . 5

- 3 Attempt any **two** of the following :
- (a) Define Bio Savart law and Amper's law A **10**
 long, straight conductor cross section with radius
 a has a magnetic field strength $\vec{H} = \left(\frac{Ir}{2\pi a^2}\right) \hat{a}_\phi$
 with in the conductor ($r < a$) and $\vec{H} = \left(\frac{I}{2\pi r}\right) \hat{a}_\phi$
 for ($r < a$). Find \vec{J} in both the region.
- (b) A charge a particle of mass 2 kg and charge **10**
 IC starts at the origin with velocity $3\hat{a}_y$ m/s
 and travels in the region of uniform magnetic
 field $\vec{B} = 10\hat{a}_z$ Wb/m² At $t = 4s$, calculate
 (i) The velocity and acceleration of the particle.
 (ii) The magnetic force on it.
 (iii) Kinetic energy and localon
- (c) Consider the loop of Fig. (1). If **10**
 $\vec{B} = 0.5\hat{a}_z$ Wb/m², $R = 20\ \Omega$, $l = 10\text{ cm}$
 and the rod is moving with a constant velocity
 of $8\hat{a}_x$ m/s, find :
 (i) The induced emf in the rod
 (ii) The current through the resistance
 (iii) The motional force on the rod
 (iv) The power dissipated by the resistance.



- 4 Attempt any two of the following :
- (a) A lossy dielectric has an intrinsic impedance **10** of $200 \angle 30^\circ \Omega$ at a particular frequency. If at that frequency the plane wave propagating through the dielectric has the magnetic field component
- $$\vec{H} = 10 e^{-\alpha x} \cos\left(\omega t - \frac{1}{2}x\right) \hat{a}_y \text{ A/m}$$
- find \vec{E} and α and skin depth.
- (b) Determine the polarization. State of plane **10** wave with electric field
- $$\vec{E}(z, t) = \hat{a}_x 3 \cos(\omega t - kz + 30^\circ) - \hat{a}_y 4 \sin(\omega t - kz + 45^\circ) \text{ mV/m}$$
- (c) How the wave propagation takes place in **10** dispersive medium ? Light is incident from air to glass at Brewsters angle. Determine the incident and transmitted angles.
- 5 Attempt any two of the following :
- (a) Derive transmission line differential equation **10** Derive the condition of lossless transmission from it.
- (b) (i) A 50Ω lossless transmission line is **10** terminated by a load impedance $Z_l = (50 - j75)\Omega$. If the incident power is 100 mW, find the power dissipated by the load
- (ii) A transmission line operating at 500 MHz has $Z_0 = 80\Omega$, $\alpha = 0.04 \text{ N p/m}$, $\beta = 1.5 \text{ rad/m}$, find the line parameters.
- (c) Using the concept of Maxwell's equation **10** explain how waves propagate in guided waves.