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B.Tech

(SEM V) THEORY EXAMINATION 2018-19

FUNDAMENTALS OF EM THEORY

Time: 3 Hours ***Total Marks: 100***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief **2 x 10 = 20**

a. What is Gauss law?
b. What do you mean by irrotational and solenoidal field?
c. Define equipotential surface.
d. Write the differences between convection current and conduction current.
e. Define dielectric strength.
f. Explain the concept of vector magnetic potential.
g. What is Lenz's law?
h. Define intrinsic impedance and phase velocity.
i. Explain reflection coefficient and transmission coefficient.
j. What is dispersion?

SECTION B

2. Attempt any *three* of the following: **10 x 3 = 30**

a. Discuss the physical significance of gradient, divergence and curl. Also state and prove Stoke's theorem.

b. What do you mean by scalar and vector fields? Transform a vector function $B = ya_x - xa_y + za_z$ into cylindrical system.

c. Write down Poisson's and Laplace's equations in cylindrical coordinate system. Consider two concentric spheres of radii a and b, a< b. The outer sphere is kept at a potential V_o and the inner sphere at zero potential. Solve Laplace equation in cylindrical coordinates to find
(i) The potential and electric field in the region between two spheres.
(ii) Find the capacitance between them.

d. What is Ampere's law? Derive an expression for magnetic field intensity due to long hollow conducting cylinder.

e. What is uniform plane wave? A 10 GHz plane wave travelling in free space has an amplitude of E_x= 10 V/m. Find v, λ, β,η and the amplitude and direction of H.

SECTION C

3. Attempt any *one part* of the following: 10 x 1 = 10

a. 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.

b. An infinite long line charge of uniform density ρ_L coulombs/cm is situated along the z- axis. Obtain electric field intensity due to this charge using Gauss law.

4. Attempt any *one part* of the following: 10 x 1 = 10

a. Explain the phenomenon of polarization in dielectric material. Determine the energy stored in the electric field in a concentric spherical shell.

b. Write the properties of perfect conductors. Find the magnitude of the electric field intensity in a sample of silver having σ = 6.17 x 10^7mho/m and μ_e= 0.0056 m^2/V-s if :
   (i) The drift density is 1 mm/s
   (ii) The current density is 10^7A/ m^2
   (iii) The sample is a cube, 3 mm on a side, carrying a total current of 80A
   (iv) The sample is a cube, 3 mm on a side, having a potential difference of 0.5 mV between opposite faces.

5. Attempt any *one part* of the following: 10 x 1 = 10

a. Verify divergence theorem for a vector field $\vec{A}$ = $3xa_x+(3y+z)a_y+ (3z-x)a_z$ in the region bounded by the cylinder x+y = 9 and the planes x=0, y=0, z=0 and z=2

b. State and explain Biot-Savart law. Also derive an expression for the magnetic field intensity due to infinite long straight filament.

6. Attempt any *one part* of the following: 10 x 1 = 10

a. What is the physical significance of displacement current? Also derive the equation of continuity for time varying fields.

b. State and explain Maxwell's equation in differential and integral form. Also write the physical significance of Maxwell's equation.

7. Attempt any *one part* of the following: 10 x 1 = 10

a. Derive a relation between vector E and vector H in uniform plane wave.

b. In region 1, $y < 0$, $\varepsilon_1 = 10$ p F/ m, $\mu_1 = 2.35\mu$ H/m and $\sigma_1 = 0$, for region 2, $y>0$, $\varepsilon_2 = 9$ p F/ m, $\mu_2 = 4\mu$ H/m and $\sigma_2 = 0$. An incident uniform plane wave in region 1 having electric field strength of 500 $e^{-\gamma y}$ V/m travelling towards the boundary at y=0. Find

(i) Total electric field intensity in region 1, (incident+ reflected) as a function of time.
(ii) Magnetic field intensity in region 2, as a function of time