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**Question Paper Code : 10532**

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Fourth Semester

Electronics and Communication Engineering

EC 8451 — ELECTROMAGNETIC FIELDS

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write Stoke's theorem.
2. Four like charges of  $30 \mu\text{C}$  each are located at the four corners of a square, the diagonal of which measures 8 m. Find the force on a  $150 \mu\text{C}$  charge located 3 m above the center of the square.
3. Give the expressions which mutually relate Electric field and Potential.
4. Find the capacitance per unit length of two coaxial metal cylindrical tubes of radii  $a$  (inner) and  $b$  (outer).
5. If Magnetic field  $B = 25x\hat{i} + 12y\hat{j} + \alpha z\hat{k}$  (T), find  $\alpha$ .
6. Prove that magnetic forces do not work.
7. Define conduction current and displacement current densities.
8. Write Wave equations.
9. Find the Poynting vector on the surface of along, straight conducting wire (of radius 'b' and conductivity  $\sigma$ ) that carries a direct current I.
10. Define Brewster's angle.

PART B — (5 × 13 = 65 marks)

11. (a) Derive Helmholtz's equations.

Or

- (b) State and prove fundamental theorems of Gradient, Divergence and Curl with example.

12. (a) Planes  $x = 2$  and  $y = -3$ , respectively, carry charges  $10 \text{ nC/m}^2$  and  $15 \text{ nC/m}^2$ . If the line  $x = 0, z = 2$  carries charge  $10\pi \text{ nC/m}$ , calculate E at  $(1, 1, -1)$  due to the three charge distributions.

Or

- (b) A  $10 \mu\text{C}$  charge is at the origin of a spherical coordinate system. Calculate the electric flux crossing the portion of a spherical shell described by  $0 \leq \theta \leq \pi/4$ .

13. (a) Find the magnetic field a distance  $s$  from a long straight wire carrying a steady current  $I$ , using

(i) Biot-Savart law and (6)

(ii) Ampere's law. (7)

Or

- (b) Find the flux crossing the portion of the plane  $\phi = \pi/4$  defined by  $0.01 < r < 0.05 \text{ m}$  and  $0 < z < 2 \text{ m}$ . A current filament of  $2.5 \text{ A}$  along the  $z$  axis is in positive  $z$  direction.

14. (a) Explain how Maxwell fixed Ampere's law. Write Maxwell's equations in differential and integral forms.

Or

- (b) Derive electromagnetic boundary conditions.

15. (a) Analyze the reflection and transmission of waves at boundaries under oblique incidence and derive the Fresnel's equations.

Or

- (b) State and derive Poynting's Theorem.

PART C — (1 × 15 = 15 marks)

16. (a) The electric field intensity of a linearly polarized uniform plane wave propagating in the +z direction in seawater is  $\vec{E} = 100 \cos(10^7 \pi t) \hat{i} \text{ V/m}$  at  $z = 0$ . The constitutive parameters of seawater are  $\epsilon_r = 82$ ,  $\mu_r = 1$  and  $\sigma = 5 \text{ S/m}$ . Determine the attenuation constant, phase constant, intrinsic impedance, phase velocity, wavelength and skin depth. Also find the distance at which the amplitude of  $\vec{E}$  is 2% of its value at  $z = 0$ . Write the expression for  $E(z, t)$  at  $z = 0.9 \text{ m}$  as a function of  $t$ . (15)

Or

- (b) (i) Determine the polarization of the wave if the electric field intensity in a region is given by  $\vec{E} = (3\vec{a}_x + j4\vec{a}_y)e^{-0.2x} e^{-j0.5z} \text{ V/m}$ . (8)
- (ii) A sinusoidal electric intensity of amplitude 250 V/m and frequency 1 GHz exists in a lossy dielectric medium that has a relative permittivity of 2.5 and loss tangent of 0.001. Find the effective conductivity of the lossy medium. (7)

