CBCS SCHEME

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18EE45

Fourth Semester B.E. Degree Examination, June/July 2025
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Derive the relationship between Cartesian and spherical co-ordinate systems? Parameters. **(06 Marks)**

b. Define :
i) Electric flux density
ii) Electrical field Intensity
iii) Volume charge density **(06 Marks)**

c. Given that $D = z\rho\cos^2\phi \; a_z \; C/m^2$, calculate the charge density at $(1, \pi/4, 3)$ and the total charge enclosed by the cylinder of radius 1 m with $-2 \le z \le 2$ m. **(08 Marks)**

OR

2 a. Two particles having charges 2 nano-coulomb and 5 nano-coulomb are spaced 80 cm apart. Determine the electric field intensity at a point "A" situated at a distance of 0.5 m from each of the two particles. [Assume bakelite medium with $E_r = 5$] **(08 Marks)**

b. Using Gauss's Law obtain an expression for "E" due to infinite sheet of charge with surface charge density $\rho_s \; C/m^2$. **(07 Marks)**

c. Transform vector $B = ya_x - xa_y + za_z$ into cylindrical co-ordinates. **(05 Marks)**

Module-2

3 a. Derive an expression for potential difference between points at $\rho = a$ and $\rho = b$ in the field of an infinite line charge with charge density ρ_L C/m. **(06 Marks)**

b. Derive the boundary conditions on E and D at the interface of perfect dielectrics. **(10 Marks)**

c. Show that $\oint E.dL = 0$ **(04 Marks)**

OR

4 a. In a certain region, the potential is given by $V = (x^2 + 3y^2 + 9z)$. Find the electric field intensity at point P (1,-2,3) m. **(04 Marks)**

b. Two dipoles with dipole moments $-5a_z$ nC/m and $9a_z$ nC/m are located at points (0,0, -2) and (0,0,3) respectively. Find the potential at the origin. **(08 Marks)**

c. Derive the expression for capacitance of two concentric spherical shells with inner radius R_1 and outer radius R_2. **(08 Marks)**

Module-3

5 a. State and prove uniqueness theorem. **(08 Marks)**

b. A sphere of radius 'a' has the charge distribution $\rho(r)$ C/m^3, which produces an electric field intensity given by,
$E_r = Ar^4$, for $r \le a$,
$= Ar^{-2}$, for $r > a$,
Where 'A' is a constant. Find the corresponding charge distribution $\rho(r)$, using Poisson's equation. **(12 Marks)**

OR

6 a. State and explain :
i) Biot Savart law
ii) Ampere's circuital law
iii) Stoke's theorem. **(12 Marks)**

b. A circuit carrying a direct current of 5A from a regular hexagon inscribed in a circle of radius 1m. Calculate the magnetic flux density at the center of the current hexagon. Let medium to be free space. **(08 Marks)**

Module-4

7 a. Derive Lorentz force equation and mention its application. **(06 Marks)**

b. Discuss the magnetic boundary conditions application to B, H and M at the interface between two different magnetic materials. **(10 Marks)**

c. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60 cm. and diameter 6cm given that medium is air. **(04 Marks)**

OR

8 a. A positive point charge Q = 20(nc) is moving with a velocity of 12×10^6 (m/s) in a direction specified by the unit vector $a_u = -0.48a_x - 0.6a_y + 0.64a_z$
i) Find the magnitude of vector force exerted on a moving particle by the magnetic field $B = 2a_x - 3a_y + 5a_z$ (MT).
ii) Find the magnitude of vector force exerted on the moving particle by the electric field. $E = 2a_x - 3a_y + 5a_z$ (KV/m).
iii) Find the magnitude of vector force if both B and E would be acting together. **(10 Marks)**

b. Derive the expression for torque on a rectangular loop carrying current I. **(10 Marks)**

Module-5

9 a. Derive emf equation for
i) Stationary loop in time varying "B" field (Transformer emf)
ii) Moving loop in static "B" field (Motional emf). **(12Marks)**

b. List Maxwell's equation for time varying field in integral form and point form. **(08 Marks)**

OR

10 a. Derive an expression for the relation between E & H in a conducting medium of lossy dielectrics. **(10 Marks)**

b. The electric field in free space is given by $E = 800 \cos [10^8 t - \beta y] a_z$ V/m.
Find :
i) β ii) λ and iii) H at the point P (1, 1.5, 0.4) at t = 8 ns. **(10 Marks)**

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