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CBCS SCHEME

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15EC36

Third Semester B.E. Degree Examination, June/July 2019
Engineering Electromagnetics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Four point charges each 20μc are on x-y axes at ± 4m. find the force on a 100μc point charge at (0, 0, 3)m. **(06 Marks)**

b. Define electric field intensity ($\vec{E}$) and using Coulomb's law derives the expression for $\vec{E}$ due to a point charge. **(04 Marks)**

c. A line charge of density $\rho_\ell = 24$ n c/m is located in free space on the line y = 1, z = 2. Find electric filed intensity $\vec{E}$ at P(6, −1, 3). **(06 Marks)**

OR

2 a. Derive an expression for Electric field Intensity $\vec{E}$ due to an infinite line charge of density ρ_ℓ c/m. **(08 Marks)**

b. A point charge of 6μc is located at origin and a uniform line charge of density 180nc/m lies along x – axis,
   i) Find electric flux density D at (1, 2, 4)
   ii) Calculate the total electric flux leaving the surface of a sphere of 4m radius centered at origin. **(08 Marks)**

Module-2

3 a. A charge of Q coulombs is uniformly distributed throughout the volume of a sphere of radius 'R' meters. Using Gauss law Find electric field intensity 'E' everywhere. Plot the variation of E with radial distance. **(08 Marks)**

b. Given that $D = \frac{5r^2}{4} a_r$ in spherical co-ordinates evaluate both sides of Divergence Theorem for the volume enclosed between r = 1m and r = 2m. **(08 Marks)**

OR

4 a. Find the work done in moving a 5μc point charge from origin to p(2, −1, 4) through $E = 2xyz\, a_x + x^2 z\, a_y + x^2 y\, a_z$ v/m via the path
   i) Straight line segment (0, 0, 0) to (2, 0, 0) to (2, −1, 0) to (2, −1, 4)
   ii) Straight line x = −2y, z = 2x. **(10 Marks)**

b. Given potential function $V = 50x^2yz + 20y^2$ V in free space find
   i) Voltage at p(1, 2, -3)
   ii) E at P
   iii) a_N at P **(06 Marks)**

Module-3

5 a. Using Laplace Equation derive the expression for capacitance of co-axial cylindrical capacitor. Assume the potential is a function of 'ρ' only. The boundary condition are V = 0 at ρ = b and V = V_0 at ρ = a (b > a) **(08 Marks)**

b. Conducting planes at ϕ = 10° and ϕ = 0° in cylindrical co-ordinates have voltages of 75V and 0 V respectively. Obtain the expression for Electric flux density 'D' in the region between the planes which contains a material for which E_r = 1.65. **(08 Marks)**

OR

6 a. Using Biot - Savart's law derive an expression for magnetic field intensity 'H' due to an infinite current carrying conductor at any point P. **(08 Marks)**

b. In cylindrical co-ordinates magnetic field H = $(2\rho - \rho^2)$ aϕ A/m. for $0 \le \rho \le I$.

i) Determine current density 'J'

ii) What total current passes through a surface z = 0, $0 \le \rho \le 1$. **(08 Marks)**

Module-4

7 a. Derive Lorentz force equation for a moving charge in both electric and magnetic fields. **(04 Marks)**

b. The point charge Q = 18nc has a velocity of 5 × 10^6 m/s in the direction $q_v = 0.60\,a_x + 0.75\,a_y + 0.30a_z$. Calculate magnetic force exerted on the charge by

i) B = −3ax + 4ay + 6az MT

ii) E = −3ax + 4ay + 6az KV/m **(06 Marks)**

c. The magnetization in a magnetic material for which $\chi_m = 8$ is given in a certain region as $150z^2\,a_x$ A/m. At z = 4cm, find the magnitude of J and J_b. **(06 Marks)**

OR

8 a. Derive the expression for boundary conditions for magnetic flux density B, magnetic field intensity H and magnetization M for both normal and tangential field. **(08 Marks)**

b. Let μ_1 = 5 μH/m in region A where x < 0 and μ_2 = 20μH/m in region B where x > 0. If there is a surface current density K = 150 a_y − 200 a_z A/m at x = 0 and if $H_A = 300\,a_x - 400a_y + 500a_z$ A/m find (i) $|H_{tA}|$ (ii) $|H_{NA}|$ (iii) $|H_{tB}|$ (iv) $|H_{NB}|$ **(08 Marks)**

Module-5

9 a. What was the inconsistency of Ampere's law with continuity equation? How was it modified by Maxwell? **(06 Marks)**

b. Show that the displacement current in the dielectric of parallel plate capacitor is equal to conduction current between the two plates. **(04 Marks)**

c. Given E = E_m Sin(wt − βz) a_y V/m in free space find, D, B and H. **(06 Marks)**

OR

10 a. Show that the intrinsic impedance defined as $\eta = \frac{|E|}{|H|}$ is equal to $\sqrt{\frac{\mu}{\epsilon}}$ for a perfect dielectric and hence prove that for free space η = 377Ω. **(08 Marks)**

b. A wave propagation in a lossless dielectric has the components

E = 500 Cos $(10^7 t - \beta z)\,a_x$ V/m

H = 1.1 Cos $(10^7 t - \beta z)\,a_y$ A/m

If the wave is travelling at v = 0.5C , where 'C' is velocity of light in free space find μ_r, ϵ_r, β, λ. **(08 Marks)**