CBCS SCHEME

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17EE45

Fourth Semester B.E. Degree Examination, July/August 2021
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. Derive the relationship between rectangular and cylindrical coordinates. **(05 Marks)**

b. Using surface integral obtain an expression for surface area of a sphere of radius r_1 meter. **(05 Marks)**

c. Vector's $A = 5U_x + 4U_y + 3U_z$ and $B = 2U_x + 3U_y + 4U_z$ are situated at a point x, y, z, find: (i) A + B (ii) A · B (iii) angle between A and B (iv) A × B (v) Unit normal to the plane containing A and B. **(10 Marks)**

2 a. State and explain Gauss's law. Given that $\bar{D} = \frac{\rho^2 z^2}{3}\cos\phi\,\bar{a}_\phi$. Determine the flux crossing $\phi = \frac{\pi}{4}$ half plane defined by $0 \le \rho \le 3$ and $2 \le z \le 4$. **(10 Marks)**

b. Derive Gauss Divergence theorem. **(10 Marks)**

3 a. Establish relation $E = -\nabla V$. **(08 Marks)**

b. If $V = xy + x - y + zy$ Volts, find the electric field intensity at a point (1, 2, 3) and energy stored in a cube of scale 2m. **(06 Marks)**

c. A parallel plate capacitor of 8 nf has an area of 1.51 m^2 and separation of 10 mm. what separation would be required to obtain the 10 nf capacitance between the plates. **(06 Marks)**

4 a. Derive the boundary conditions the interface between a conductor and dielectric interface. **(10 Marks)**

b. Derive the expression for capacitance of a parallel plate capacitor. **(05 Marks)**

c. A point charge of 1 μc is at y = –3 mt and another point charge of 2 μc is at y = 3 mt, find the electrical potential at a point P(4, 0, 0) mts. **(05 Marks)**

5 a. Prove uniqueness theorem. **(10 Marks)**

b. Determine whether or not the following potential fields satisfy the Laplace's equations.
(i) $v = x^2 - y^2 + z^2$ (ii) $v = r\cos\phi + z$ (iii) $v = r\cos\phi + \phi$ **(10 Marks)**

6 a. Derive Ampere's law in difference form. **(10 Marks)**

b. Given the general vector $\vec{A} = (\sin 2\phi)\hat{a}_\phi$ on cylindrical coordinates at $\left(2, \frac{\pi}{4}, \phi\right)$. Find curl of a vector. **(05 Marks)**

c. State Biot-Savart's law and Ampere's circuital law. **(05 Marks)**

7 a. Derive an expression for the force on a differential current element placed in a magnetic field and deduce the result for straight conductor in a uniform magnetic field. **(10 Marks)**

b. State and explain Lorentz force equation. **(05 Marks)**

c. A point charge of Q = –1.2 C has velocity $\overline{V} = 5\hat{a}_x + 2\hat{a}_y - 3\hat{a}_z$ m/s. find the magnitude of the force exerted on the charge if
(i) $\overline{E} = -18\hat{a}_x + 5\hat{a}_y - 10\hat{a}_z$ v/m
(ii) $\overline{B} = -4\hat{a}_x + 4\hat{a}_y + 3\hat{a}_z$ T
(iii) Both are present simultaneously. **(05 Marks)**

8 a. Derive the expression for the inductance of a toroid. **(06 Marks)**
b. An air cored toroid has a cross-sectional area of 6 cm^2, a mean radius of 15 cm and is wound with 500 turns and carries a current of 4A, find the magnetic field intensity at the mean radius. **(06 Marks)**
c. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60 cm and diameter 6 cm. Derive the exp. used. **(08 Marks)**

9 a. Derive continuity equation from Maxwell equation. **(10 Marks)**
b. The circular loop conductor having a radius of 0.15 m is placed on x-y plane. This loop consist of a resistance of 20Ω. If the magnetic flux density is $\overline{B} = 0.5 \sin 10^3 t \hat{a}_z$ T. **(10 Marks)**

10 a. Starting from Maxwell's equation obtain the general wave equation's on electrical and magnetic fields. **(10 Marks)**
b. Wet Marshy soil is characterized by $\sigma = 10^{-2}$ S/M, $\epsilon_r = 15$ and $\mu_r = 1$. Show that at 60 Hz. It can be considered as good conductor. Hence at 60 Hz. Calculate:
(i) Skin depth
(ii) Intrinsic impedance
(iii) Propagation constant **(10 Marks)**

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