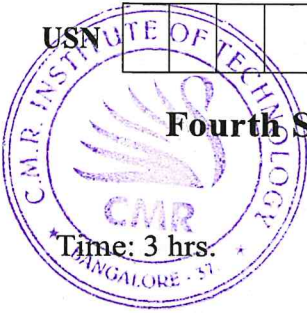


# CBCS SCHEME

USN

17EE45



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

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)  $A \cdot B$  (iii) angle between  $A$  and  $B$  (iv)  $A \times B$  (v) Unit normal to the plane containing  $A$  and  $B$ . (10 Marks)
- 2
  - a. State and explain Gauss's law. Given that  $\vec{D} = \frac{\rho^2 z^2}{3} \cos\phi \bar{a}_\phi$ . Determine the flux crossing  $\phi = \frac{\pi}{4}$  half plane defined by  $0 \leq \rho \leq 3$  and  $2 \leq z \leq 4$ . (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  $8 \text{ nf}$  has an area of  $1.51 \text{ m}^2$  and separation of  $10 \text{ mm}$ . what separation would be required to obtain the  $10 \text{ nf}$  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  $1 \mu\text{c}$  is at  $y = -3 \text{ mt}$  and another point charge of  $2 \mu\text{c}$  is at  $y = 3 \text{ mt}$ , find the electrical potential at a point  $P(4, 0, 0) \text{ mts}$ . (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  $\vec{A} = (\sin 2\phi)\bar{a}_\phi$  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  $\vec{V} = 5\hat{a}_x + 2\hat{a}_y - 3\hat{a}_z$  m/s. find the magnitude of the force exerted on the charge if
- $\vec{E} = -18\hat{a}_x + 5\hat{a}_y - 10\hat{a}_z$  v/m
  - $\vec{B} = -4\hat{a}_x + 4\hat{a}_y + 3\hat{a}_z$  T
  - Both are present simultaneously.
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BANGALORE - 560 037 (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  $6 \text{ cm}^2$ , 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  $20\Omega$ . If the magnetic flux density is  $\vec{B} = 0.5 \sin 10^3 t \hat{a}_z$  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:
- Skin depth
  - Intrinsic impedance
  - Propagation constant
- (10 Marks)

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