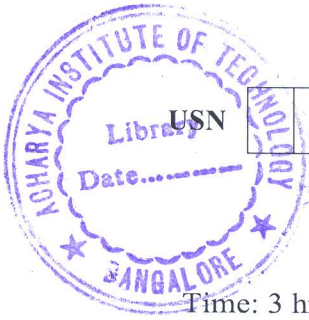


# CBCS SCHEME

15EE45



## Fourth Semester B.E. Degree Examination, Jan./Feb. 2021 Electromagnetic Field Theory

Time: 3 hrs.

Max. Marks: 80

- Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.  
2. Draw neat figures wherever necessary.*

### Module-1

- 1 a. Explain spherical coordinate system. Also derive the relation between spherical and Cartesian coordinate system. (08 Marks)
- b. Find the gradient of the following scalar fields
- i)  $t = x^2y + e^z$
- ii)  $w = 10r \sin^2\theta \cos \phi$  (04 Marks)
- c. If  $\vec{F} = (x + 2y + az)\hat{a}_x + (bx - 3y - z)\hat{a}_y + (4x + cy + 2z)\hat{a}_z$   
Find the constants a, b and c so that  $\vec{F}$  is irrotational. (04 Marks)

OR

- 2 a. Derive an expression for electric field intensity at a point 'P' due to surface charge. (06 Marks)
- b. State and prove Gauss's law. (06 Marks)
- c. Three point charges  $1\mu\text{C}$ ,  $1\mu\text{C}$  and  $0.5\mu\text{C}$  are placed in air at the corners of an equilateral triangle of 0.5m side. Find the force on  $0.5\mu\text{C}$  charge. (04 Marks)

### Module-2

- 3 a. Derive an expression for electric potential at a point due to a point charge. (06 Marks)
- b. If  $V = x - y + xy + 2z$  volts. Find the electric field intensity at  $P(1, 2, 3)$  and also the energy stored in a cube of side 2 mts centered at the origin. (06 Marks)
- c. Given the potential field  $V = 3x^2y + 2y^2z + 3xyz$ . Find the electric field strength at  $M(1, 2, -1)$ . (04 Marks)

OR

- 4 a. Describe the boundary conditions between two dielectric media having permittivities  $\epsilon_1$  and  $\epsilon_2$ . (08 Marks)
- b. A parallel plate capacitor of area 'A'  $\text{m}^2$  is filled with a dielectric of permittivity  $\epsilon = \epsilon_0 \left[ 1 + \epsilon_r \left( \frac{y}{d} \right) \right]$  where  $y = 0$  at one plate and  $y = d$  at the other plate. Obtain an expression for its capacitance. (08 Marks)

### Module-3

- 5 a. Using Laplace and equation obtain the capacitance of a spherical shell having inner radius 'a' mts and outer radius 'b' mts. The inner conductor is at a potential  $V_D$  and the outer conductor is grounded. (08 Marks)
- b. Verify whether the following potential factors satisfy Laplace's equation
- i)  $V = 2x^2 - y^2 - z^2$  volts
- ii)  $V = 6e\phi z$  (04 Marks)
- c. Verify whether  $v = \frac{k}{r}$  where 'k' is a constant satisfies Laplace equation. (04 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 6 a. Derive an expression for magnetic field intensity at a point on the axis of a current carrying short solenoid. (08 Marks)
- b. Magnetic factor intensity in free space is given by  $H = 10e^2 \hat{a}_\phi$  A/m
- i) Find J
- ii) Find the current over the circular surface  $\rho = 1$  m; all  $\phi$ ;  $z = 0$  (08 Marks)

Module-4

- 7 a. Explain in brief any three magnetic materials. (06 Marks)
- b. Explain the boundary conditions between two magnetic media. (06 Marks)
- c. Calculate the inductance of a solenoid of 2000 turns wound tightly on a cylindrical tube of 6cms diameter. The length of the tube is 60 cms and the solenoid is in air. (04 Marks)

OR

- 8 a. With usual notations derive  $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ . (06 Marks)
- b. Derive Lorentz's force equation for the combined field. (06 Marks)
- c. A conductor 4m long lies along the y-axis with a current of 10 A flowing through it. Find the force on the conductor if the fields on the region is  $\vec{B} = 0.05 \hat{a}_z$  wb/m<sup>2</sup> (04 Marks)

Module-5

- 9 a. Derive Maxwell's equation for time varying fields. (08 Marks)
- b. A conductor carries a steady current of 'I' amperes. The components of current density vector are  $J_x = 2ax$  and  $J_y = 2ay$ . Find the third component  $J_z$ . Derive the relation employed. (08 Marks)

OR

- 10 a. Explain the transverse nature of electro magnetic waves. (06 Marks)
- b. Derive the relation between  $\vec{E}$  and  $\vec{H}$  for a conducting medium. (06 Marks)
- c. The depth of penetration in a certain conducting medium is 0.1m and the frequency is 1MHz. Find the conductivity of the medium. (04 Marks)

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