CBCS SCHEME

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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 1μc, 1μc and 0.5μc are placed in air at the corners of an equilateral triangle of 0.5m side. Find the force on 0.5μc 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 permitivities ϵ_1 and ϵ_2. **(08 Marks)**

b. A parallel plate capacitor of area 'A' 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)**

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 e = 1m; all ϕ; 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 $\nabla X\vec{E} = -\frac{\partial B}{\partial t}$. **(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 $\vec{B} = 0.05\hat{a}_z wb/m^2$ **(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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