CBCS SCHEME

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17EE45

Fourth Semester B.E. Degree Examination, July/August 2022
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define a scalars and vectors. For a given vectors.
$\vec{A} = 6\vec{a}_x + 2\vec{a}_y + 6\vec{a}_z$ and $\vec{B} = -2\vec{a}_x + 9\vec{a}_y - \vec{a}_z$

i) Show that vectors $\vec{A}$ and $\vec{B}$ are perpendicular to each other.

ii) Find $\vec{A} \times \vec{B}$ and show $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$. **(08 Marks)**

b. Derive the relationship between rectangular and spherical coordinates. **(06 Marks)**

c. Using surface integral obtain an expression for surface area of a sphere of radius "r_1" meter. **(06 Marks)**

OR

2 a. State and explain Coulomb's law in vector form. Mention the units involved in it. **(07 Marks)**

b. State and prove Gauss law. **(07 Marks)**

c. If $\vec{D} = 2xy\,\vec{a}_x + 3yz\,\vec{a}_y + 4zx\,\vec{a}_z\ c/m^2$, how much electric flux passes through that portion of the plane at x = 3m for which $-1 \le y \le 2m$ and $0 \le z \le 4m$. **(06 Marks)**

Module-2

3 a. Show that the electric field intensity is equal to the gradient of a potential. **(07 Marks)**

b. Determine the workdone in carrying a charge of 2C from B(1, 0, 1) to A(0.8, 0.6, 1) in an electric field $\vec{E} = y\vec{a}_x + x\vec{a}_y + 2\vec{a}_z\ v/m$ along the short arc of circle $x^2 + y^2 = 1$, z = 1. **(07 Marks)**

c. Derive the expression for potential due to a point charge. **(06 Marks)**

OR

4 a. With usual notations prove that
$\nabla.\vec{J} = -\frac{\partial \rho v}{\partial t}$. **(07 Marks)**

b. Obtain the boundary conditions between conductor and free space. **(08 Marks)**

c. A parallel plate capacitor of 8nF has an area of $1.51m^2$ and separation of 10mm. What separation would be required to obtain the 10nF capacitance between the plates? **(05 Marks)**

Module-3

5 a. Derive Poisson's and Laplace's equation. **(06 Marks)**

b. State and explain uniqueness theorem. **(08 Marks)**

c. Verify that the potential field given below satisfies the Laplace's equation.
$V = 2x^2 - 3y^2 + z^2$. **(06 Marks)**

OR

6 a. Derive an expression for magnetic field intensity at a point due to an infinite long straight conductor carrying a current of I amperes along Z-axis. **(10 Marks)**

b. Evaluate both sides of the Stoke's theorem for the field $\vec{H} = 6xy\,\vec{a}_x - 3y^2\,\vec{a}_y$ A/m and the rectangular path around the region, $2 \le x \le 5$, $-1 \le y \le 1$, $z = 0$. Let the positive direction of $d\vec{s}$ be $\vec{a}_z$. **(10 Marks)**

Module-4

7 a. Derive an expression for the force between differential current elements. **(07 Marks)**

b. Find the expression for force and torque on a closed circuit. **(06 Marks)**

c. A point charge Q = 18nC has a velocity of 5×10^6 m/s in the direction $\vec{a}_v = 0.6\,\vec{a}_x + 0.75\,\vec{a}_y + -0.3\vec{a}_z$. Calculate the magnitude of the force exerted on the charge by the field.

i) $\vec{E} = -3\vec{a}_x + 4\vec{a}_y + 6\vec{a}_z$ KV/m.

ii) $\vec{B} = -3a_x + 4\vec{a}_y + 6\vec{a}_z$ mT.

iii) $\vec{B}$ and $\vec{E}$ acting together. **(07 Marks)**

OR

8 a. Obtain the magnetic boundary conditions. **(10 Marks)**

b. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60cm and of diameter 6cm, given that medium is air. Derive the expression used. **(10 Marks)**

Module-5

9 a. Write Maxwell's equations in point form and in integral form for time varying fields. **(10 Marks)**

b. A circular loop of 10cm radius is located in x-y plane with magnetic field. $\vec{B} = 0.5\cos(377t)[3\vec{a}_x + 4\vec{a}_z]$ T. Calculate voltage induced in a loop. **(10 Marks)**

OR

10 a. Starting from Maxwell's equations obtain the general wave equations in electric and magnetic fields. **(10 Marks)**

b. The magnetic field intensity of uniform plane wave in air is 20A/m in $\vec{a}_y$ direction. The wave is propagating in the $\vec{a}_z$ direction at an angular frequency of 2×10^9 rad/sec. Find:

i) Phase shift constant
ii) Wavelength
iii) Frequency
iv) Amplitude of electric field intensity. **(10 Marks)**

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