CBCS SCHEME

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18EE45

Fourth Semester B.E. Degree Examination, Feb./Mar.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. Differentiate between Scalars and Vectors with examples. **(06 Marks)**

b. Given $\vec{A} = 6a\hat{x} + 6a\hat{y} + 6a\hat{z}$ and $\vec{B} = -2a\hat{x} + 9a\hat{y} - a\hat{z}$
Show that

(i) Vectors $\vec{A}$ and $\vec{B}$ are perpendicular to each other.

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

c. State and explain Coulamb's law. **(06 Marks)**

OR

2 a. Explain the terms :
(i) Gradient operation.
(ii) Divergence operation.
(iii) Curl operation. **(06 Marks)**

b. Obtain an expression for electric field intensity due to an infinite line charge. **(07 Marks)**

c. State and explain Gauss's law and hence obtain Maxwell's first equation. **(07 Marks)**

Module-2

3 a. Obtain an expression for energy expended in moving a point charge. **(06 Marks)**

b. Find the workdone in moving a charge of +2 coulamb from (2, 0, 0) to (0, 2, 0) m along the straight line path joining two points, if the electric field is $\vec{E} = (12xa\hat{x} - 4ya\hat{y})\ V/m$. **(08 Marks)**

c. Obtain boundary conditions at the interface of two dielectrics. **(06 Marks)**

OR

4 a. What are the properties of a good conductor? **(06 Marks)**

b. An electric field strength of 3 V/m in air enters a dielectric. The orientations of electric field with respect to boundary in air and dielectric are 30° and 60° respectively. Find the relative permittivity of the dielectric. Also find the electric field strength in dielectric. **(08 Marks)**

c. Obtain an expression for energy density. **(06 Marks)**

Module-3

5 a. Derive Poisson's and Laplace's equations. Write them in all three co-ordinate systems. **(08 Marks)**

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

c. Write a note on vector magnetic potential. **(06 Marks)**

OR

6 a. State and prove uniqueness theorem. **(06 Marks)**

b. Write the statements of,
   (i) Biot-Savart's law.
   (ii) Ampere's law and explain them. **(08 Marks)**

c. Assume $\vec{A} = 50r^2 a\hat{z}$ wb/m in a certain region of free space. Find H and B. **(06 Marks)**

Module-4

7 a. Obtain an expression for force on a moving charge. **(06 Marks)**

b. A point charge Q = 18 nC has velocity of 6 mm/s in the direction of $0.6a\hat{x} + 0.7a\hat{y} + 0.3a\hat{z}$. Calculate the magnitude of the force exerted on charge Q by a field of $\vec{B} = -3a\hat{x} + 4a\hat{y} + 5a\hat{z}$ mT. **(08 Marks)**

c. Write a note on magnetic boundary conditions. **(06 Marks)**

OR

8 a. Explain the terms, (i) self inductance (ii) mutual inductance. **(06 Marks)**

b. Obtain expressions for inductance of a solenoid and toroid. **(08 Marks)**

c. A solenoid with air core has 2000 turns and a length of 500 mm. Core radius is 40 mm. Find its self inductance. **(06 Marks)**

Module-5

9 a. Explain the terms : (i) Transformer induced emf (ii) motional emf. **(08 Marks)**

b. List Maxwell's equations in integral and differential forms. **(06 Marks)**

c. Write a note on skin effect or depth of penetration. **(06 Marks)**

OR

10 a. Do the fields $\vec{E} = E_m \sin x \sin t\, a\hat{y}$ and $\vec{H} = \frac{E_m}{\mu_0} \cos x \cos t\, a\hat{z}$ satisfy Maxwell's equation. **(07 Marks)**

b. State and explain Poynting theorem. **(07 Marks)**

c. Derive an expression for propagation constant in a good conductor. **(06 Marks)**

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