

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 Coulomb's law. (06 Marks)

OR

- 2 a. Explain the terms :
- (i) Gradient operation. (06 Marks)
- (ii) Divergence operation. (07 Marks)
- (iii) Curl operation. (07 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 coulomb 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 $\vec{A} = 50r^2 a_z$ 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 $0.6a_x + 0.7a_y + 0.3a_z$. Calculate the magnitude of the force exerted on charge Q by a field of $\vec{B} = -3a_x + 4a_y + 5a_z$ 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 $\vec{E} = E_m \sin x \sin t a_y$ and $\vec{H} = \frac{E_m}{\mu_0} \cos x \cos t a_z$ 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)
