CBCS SCHEME

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15EE45

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Electromagnetic Field Theory

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. What is a unit vector? Illustrate its significance in the vector representation. **(02 Marks)**

b. Explain Cartesian coordinate system and differential elements in Cartesian coordinate system. **(04 Marks)**

c. Define:
i) Dot product and cross product of two vectors.
ii) Gradient of a scalar field
iii) Divergence and curl of a vector field. **(10 Marks)**

OR

2 a. State and explain Coulomb's law of force between the two point charges. **(05 Marks)**

b. A point charge Q = 30nc is located at the origin in Cartesian co-ordinates. Find the electric flux density $\overline{D}$ at (1, 3, -4) m. **(05 Marks)**

c. State and explain Gauss law in electrostatics. **(06 Marks)**

Module-2

3 a. Derive an expression for energy expanded in making a point charge in an electric field. **(08 Marks)**

b. Derive an expression for the electric intensity at any point in the negative of the potential gradient at that point or $E = -\nabla V$. **(08 Marks)**

OR

4 a. With necessary relations, define current and current density. **(03 Marks)**

b. Explain the boundary conditions for a boundary between two di-electric materials. **(08 Marks)**

c. A capacitor consists of two metal plates each 100cm^2 placed parallel and 2mm apart. The whole of space between the plates is filled with a di-electric having a relative permittivity of 3.5. A potential difference of 500V is maintained between the plates. Calculate:
i) The capacitance
ii) The charge on capacitor
iii) Electric flux density
iv) Potential gradient. **(05 Marks)**

Module-3

5 a. Derive Poisson's and Laplace equations starting from point form of Gauss law. **(06 Marks)**

b. Verify that the potential field given below satisfies the Laplace's equation $V = 2x^2 - 3y^2 + z^2$ **(02 Marks)**

c. State and prove Unigueness theorem. **(08 Marks)**

OR

6 a. State and explain Biot-Savart's law. (06 Marks)

b. State and explain Stoke's theorem. (04 Marks)

c. Derive an expression for vector magnetic potential. (06 Marks)

Module-4

7 a. Derive an expression for the force between differential current elements. (08 Marks)

b. A point chart of Q = -1.2C has velocity $\bar{v} = (5\bar{a}x + 2\bar{a}y - 3\bar{a}z)m/s$. Find the magnitude of the force exerted on the charge if,

i) $\bar{E} = -18\bar{a}x + 5\bar{a}y - 10\bar{a}z \ v/m$

ii) $\bar{B} = -4\bar{a}x + 4\bar{a}y + 3\bar{a}z \ T$

iii) Both are present simultaneously (08 Marks)

OR

8 a. Derive the boundary conditions at the interface between two magnetic materials of different permeabilities. (08 Marks)

b. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of 6cm diameter. The length of the tube is 60cm and the solenoid is in air. (02 Marks)

c. Define mutual inductance. Derive an expression for mutual inductance of two different coils. (06 Marks)

Module-5

9 a. Explain briefly Faraday's law and displacement current for time varying fields. (07 Marks)

b. In a given lossy dielectric medium conduction current density $J_C = 0.02Sin10^9 t(A/m^2)$. Find the displacement current density if $\sigma = 10^3$ s/m and $\varepsilon_r = 6.5$. (03 Marks)

c. Write Maxwell's equations in point form and in integral form for time varying fields. (06 Marks)

OR

10 a. Discuss the propagation of uniform plane waves in a lossless medium. (06 Marks)

b. Define poynting vector and explain the power flow associated with it. (06 Marks)

c. A 300MHz uniform plane wave propagates through fresh water for which $\sigma = 0$, $\mu_r = 1$ and $\epsilon_r = 78$. Calculate:

i) The attenuation constant

ii) The phase constant

iii) The wave length. (04 Marks)

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