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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