CBCS SCHEME

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18EE45

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
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 scalar and vector. For a given vectors $A = \left(6\bar{a}_x + 2\bar{a}_y + 6\bar{a}_z\right)$ and $B = \left(-2\bar{a}_x + 9\bar{a}_y - \bar{a}_z\right)$. Find dot and cross product between two vectors $\bar{A} + \bar{B}$. Are the vectors $\perp$ to each other? **(08 Marks)**

b. Obtain the relationship between rectangular and cylindrical co-ordinate system. **(06 Marks)**

c. State and explain Coulomb's Law in vector form. **(06 Marks)**

OR

2 a. Find $\bar{H}$ in Cartesian coordinates of the vector field $\bar{H} = 20\bar{a}_\rho - 10\bar{a}_\phi + 3\bar{a}_Z$ at the point $P(x = 5, y = 2, z = -1)$. **(06 Marks)**

b. State and derive Gauss theorem of electrostatics. **(06 Marks)**

c. Two point charges 20nc and –20nc are situated at $Q_1(1, 0, 0)$ and $Q_2(0, 1, 0)$ in free space. Determine electric field intensity $(\bar{E})$ at (0, 0, 1). **(08 Marks)**

Module-2

3 a. Show that electric field intensity is a negative potential gradient. **(07 Marks)**

b. Derive an expression for current continuity equation in point form. **(06 Marks)**

c. Derive boundary conditions between conductor and a dielectric medium (free space). **(07 Marks)**

OR

4 a. Determine the work done in carrying a charge –2C from (2, 1,–1) to (8, 2, –1) in the electric field $E = y\bar{a}x + x\bar{a}yV/m$ along the straight lime path joining 2 points. **(08 Marks)**

b. What is an electric dipole? Obtain the expression for $\bar{E}$ due to an electric dipole. **(05 Marks)**

c. Derive the expression for a potential at a point due to a point charge. **(07 Marks)**

Module-3

5 a. Derive Laplace equation and Poisson's equation from point form of Gauss law in all the three co-ordinate system. **(06 Marks)**

b. Verify whether the potential fields given satisfies the Laplace's equation : $V = 2x^2 - 3y^2 + z^2$, $V = \rho^2 + z^2$. **(07 Marks)**

c. State and explain uniqueness theorem. **(07 Marks)**

OR

6 a. State and explain Blot-Savart's Law and Ampere's circuit Law. **(07 Marks)**

b. Derive an expression for magnetic field intensity at a point due to an infinite long straight conductor carrying a current I amps long Z-axis. **(07 Marks)**

c. Determine the current density J if the magnetic field intensity. $\bar{H} = (3y - 2)\bar{a}_z + 2x\bar{a}_y$ is given. **(06 Marks)**

Module-4

7 a. Derive the expression for Lorentz force equation. **(06 Marks)**

b. Given the field $\bar{B} = -2a\bar{x} + 3a\bar{y} + 4a\bar{z}$ m Tesla in free space. Find the vector force excreted on a straight wire carrying a current 12A in a direction given by $\bar{a}_{AB}$, A(1, 1, 1) and B(2, 1, 1) **(07 Marks)**

c. Derive the boundary conditions at the interface between two magnetic materials of different permeabilities. **(07 Marks)**

OR

8 a. Derive the expression for magnetic force between two differential current elements. **(07 Marks)**

b. Calculate the inductance of solenoid of 400 turns on a cylindrical tube of 10cm diameter and 50 cm length. Assume solenoid is in air. **(07 Marks)**

c. Calculate the self inductance of 3.5m of co-axial cable with a = 0.8mm and b = 4mm filled with a material $\mu_r = 50$. **(06 Marks)**

Module-5

9 a. Using Faraday's Law, Derive an expression for transformer emf(varying field, path is stationary). **(07 Marks)**

b. State Maxwell's equation in point and integral form for time varying fields from Faraday's Law. **(06 Marks)**

c. The circular loop conductor at Z = 0 plane has a radius of 0.1m has a resistance of 5Ω, if $B = 0.2\sin 10^3 t\bar{a}_z T$. Find the current in the coil. **(07 Marks)**

OR

10 a. Explain skin effect and obtain the expression to find skin depth. **(07 Marks)**

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

c. A uniform plane wave with 10MHz frequency has average poynting vector $1 W/m^2$, if the medium is perfect dielectric with $\mu_r = 2$, $\epsilon_r = 3$, find : i) velocity ii) wavelength iii) intrinsic impedance. **(06 Marks)**

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