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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Electrical and Electronics Engineering

Semester End Examination; June - 2017

Electromagnetic Field Theory

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. State and explain experimental law of coulomb. 4

b. Derive the expression for electric field intensity due to an infinite line charge with uniform charge distribution ρ_L C/m. 8

c. A line charge density ρ_L = 24 nC/m is located in free space on the line Y = 1 m and Z = 2 m.

i) Find E at the point P(6, -1, 3)

ii) What point charge Q_A should be located at A(-3, 4, 1) to make Y component of total $\bar{E}$ zero at P. 8

2 a. Using Gauss's law, derive $\bar{D}$ and $\bar{E}$ in all the regions for a spherical shell of charge having surface charge density $\rho_s C/m^2$. 8

b. State and explain Maxwell's first equation. 4

c. If $\bar{D} = xy^2z^2\bar{a}_x + x^2yz^2\bar{a}_y + x^2y^2z\bar{a}_z$ C/m^2, find

i) an expression for ρ_v

ii) The total charge within the cube defined by $0 \le x \le 2, 0 \le y \le 2, 0 \le z \le 2$ 8

UNIT - II

3 a. Explain the following:

i) Potential at a point due to sheet of charge ii) Relation between E and V. 8

b. Describe briefly on energy density in the electrostatic field. 6

c. Given $V = 2x^2y - 5z$ at point p(-4, 3, 6). Find the potential, electric field intensity and volume charge density. 6

4 a. Point charges Q_1 = 1nC, Q_2= -2nC; Q_3 = 3nC and Q_4 = -4nC are placed one by one in the same order at (0, 0, 0), (1, 0, 0), (0, 0, -1) and (0, 0, 1) respectively. Calculate the energy in the system when all charges are placed. 6

b. State and prove uniqueness theorem. 8

c. Determine whether or not the following potential field satisfies the Laplace's equation:

i) $V = x^2 - y^2 + z^2$

ii) $V = r\cos\phi + z$. 6

Contd…2

UNIT - III

5 a. Define conduction current density J and write an explanatory note on continuity equation of current. 10

b. Derive point form of ohm's law. 4

c. Find the current crossing the portion of Y = 0 plane defined by $-0.1 \leq X \leq 0.1m$ and $-0.002 \leq Z \leq 0.002$ m, if $\bar{J} = 10^2 |X| \bar{a}_y$ where $\bar{J}$ is the current density. 6

6. a Discuss the boundary conditions between two perfect dielectrics. 10

b. Derive an expression for capacitance of a co-axial cable. 6

c. A spherical condenser has a capacity of 54 pF. It consists of two concentric spheres differing in radii by 4cm and having air as dielectric. Find their radii. 4

UNIT - IV

7 a. State and explain Biot-Savart's law. 6

b. Derive an expression for magnetic field intensity ($\bar{H}$) due to straight conductor of finite length. 8

c. An infinitesimal length 10^{-3} m of wire is located at the point (1, 0, 0) and carrier a current 2 A in the direction of the unit vector $\bar{a}_x$. Find the magnetic field intensity due to the current element at the point (0, 2, 2). 6

8 a. State and prove Ampere's circuital law. 6

b. Let $\bar{A} = (3y - z)\bar{a}_x + 2xz\bar{a}_y$ wb/m in a certain region of free space.

i) Show that $\nabla . \bar{A} = 0$ ii) At P (2, -1, 3) find $\bar{A}, \bar{B}, \bar{H}$ and $\bar{J}$. 8

c. Write a note on scalar and vector magnetic potentials. 6

UNIT - V

9 a. State and explain Faraday's law for induced EMF. 8

b. Explain Faraday's law applied to, i) Stationary path, changing field ii) Steady field moving circuit. Derive necessary relationships. 6

c. A circular loop of 10 cm radius is located in X-Y plane with magnetic field $\bar{B} = 0.5\cos(377t)\left[3\bar{a}_x + 4\bar{a}_z\right] T$. Calculate voltage induced in a loop. 6

10 a. Derive an expression for force between two parallel conductors. 8

b. A point charge of Q = -1.2C has velocity $\bar{V} = \left(5\bar{a}_x + 2\bar{a}_z - 3\bar{a}_z\right)$ 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) $\bar{B} = -4\bar{a}_x + 4\bar{a}_y + 3\bar{a}_z;\quad T$ 6

c. A solenoid with $N_1 = 2000$, $r_1 = 2$ cm and $l_1 = 100$ cm is concentric within a second coil of $N_2 = 4000$, $r_2 = 4$ cm and $l_2 = 100$ cm. Find mutual inductance assuming free space conditions. 6

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