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

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Electronics and Communication 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 Derive an equation for electric field at a point due to finite length of line. 6

   b. A charge QA = -20 µC is located at A (-6, 4, 7), and a charge QB = 50 µC is at B (5, 8,-2) in free space. If distances are given in meters, find force on Q_B by Q_A. 4

   c. Calculate the total charge within each of the indicated volumes: 10

   i) $0.1 \le |x|, \ |y|, \ |z| \le 0.2 : \rho_v = 1/(x^3 y^3 z^3)$;

   ii) $0 \le \rho \le 0.1, \quad 0 \le \varphi \le \pi, \quad 2 \le z \le 4; \quad \rho_v = p^2 z^2 \sin 0.6\varphi$

   iii) universe: $\rho_v = e^{-2r/r^2}$

2 a. State and explain Gauss's law and derive an equation in terms of the charge distribution. 8

   b. Point charge of 0.25 µC is located at r = 0, and uniform surface charge densities are located as follows: 2 mC/m^2 at r = 1 cm, and -0.6 mC/m^2 at r = 1.8 cm. Calculate **D** at: 6

   i) r = 0.5 cm ii) r = 1.5 cm iii) r = 2.5 cm.

   c. State and explain the vector ∇ and the Gauss divergence theorem. 6

UNIT - II

3 a. State and explain the followings along with the mathematical equations: 6

   i) Potential difference ii) Absolute potential iii) Potential gradient.

   b. With the help of necessary equation show that E=-∇ V and explain the conservative nature of electric field. 8

   c. Define the current and current density along with their equations. 6

4 a. Current density is given in cylindrical coordinates as J = -$10^6 z^{1.5}$ A_z A/m^2 in the region $0 \le \rho \le 20$ µm; for $\rho \ge 20$ µm, J = 0. 8

   i) Find the total current crossing the surface z = 0.1 m in the az direction

   ii) If the charge velocity is 2x10^6 m/s at z = 0.1 m, find ρv there

   iii) If the volume charge density at z = 0.15 m is -2000 C/m^2, find the charge velocity there.

   b. Obtain the boundary conditions for perfect dielectric materials of permittivity's €l and €2. 7

   c. State and explain the uniqueness theorem. 5

Contd….2

UNIT - III

5 a. Obtain an expression for the magnetic flux density at a point due to a current carrying straight conductor of finite length. Extend the analysis for the case of infinity long straight conductor. 10

b. Evaluate the closed line integral of H about the rectangular path $P_1(2, 3, 4)$ to $P_2(4, 3, 4)$ to $P_3(4, 3, 1)$ to $P_4(2, 3, 1)$ to P_1, given $H = 3za_x - 2x^3a_z$ A/m.

i) Determine the quotient of the closed line integral and the area enclosed by the path as an approximation to $(\nabla \times H)y$ ii) Determine $(\nabla \times H)y$ at the center of the area. 10

6. a Define the followings along with the mathematical equations:

i) Force on a charged particle ii) Force on a closed circuit iii) Torque on a closed circuit. 9

b. Explain the magnetization and permeability with the help of their equations. 6

c. Discuss the concept of magnetic boundary conditions. 5

UNIT - IV

7 a. Explain the concept of displacement current. 6

b. Briefly discuss the Maxwell's equations in integral forms. 7

c. The electric field amplitude of a uniform plane wave propagating in the a_z direction is 250 V/m. If $E = E_x a_x$ and $\omega = 1.00$ Mrad/s, find:

i) The frequency ii) the wavelength iii) the period iv) The amplitude of H. 7

8 a. Write a short note on standing wave ratio. 5

b. Explain the reflection of uniform plane waves at normal incidence. 8

c. A uniform plane wave in air is normally incident on a dielectric slab of thickness $\lambda 2/4$, and intrinsic impedance $\eta 2 = 260$. Determine the magnitude and phase of the reflection coefficient. 7

UNIT - V

9 a. Explain the effects of imperfect earth and effects of curvature of earth. 8

b. Explain the super refraction and scattering phenomena. 8

c. Briefly explain the Tropospheric Propagation. 4

10 An Ionospheric wave is reflected from a layer of height of 200 km. The takeoff angle is 20° and the earth's radius is 6370 km. Calculate the skip distance if the earth is considered as:

i) flat surface ii) spherical. 6

b. Calculate the skip distance for flat earth with MUF of 10 MHz if the wave is reflected from a height of 300 km where the maximum value of n is 0.9. 8

c. Explain the term critical frequency, MUF, LUF. 6

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