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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; May / June - 2019

Electromagnetic 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 Coulomb's law in vector form. 6

b. A charge $Q_A = -20\ \mu C$ is located at A (– 6, 4, 7) and charge $Q_B = 50\ \mu C$ is located at (5, 8, –2) in free space. If the distance is in meters. Find *r* and the force exerted on Q_A by Q_B. 7

c. Find the electric field intensity due to a line charge distribution, ρ_L (c/m) of length, L where the charge is uniformly distributed along the line. 7

2 a. Explain the following terms:

i) Electric flux

ii) Electric flux density 6

b. State and prove Gauss's law. 7

c. Given, $D = 5r\hat{a}_r \left(c/m^2\right)$. Determine whether the divergence theorem holds good for the region enclosed by a spherical surfaces at *r* = a and *r* = b (b > a) and at the centered at the origin. 7

UNIT - II

3 a. The electric potential at an arbitrary point in free space is given as, $V = (x+1)^2 + (y+2)^2 + (z+3)^2$ *V* at P(1, 1, 1). Find V, E, D and δ_V. 6

b. Determine the energy stored in free space of the region : $0 < \rho < a,\ 0 < \phi < \pi,\ 0 < z < 2$ for the given potential field $V = V_0 \frac{\rho}{a}$ (volts). 7

c. Derive an expression for energy density in an electro static field. 7

4 a. Starting from fundamentals derive the expressions for Laplace and Poison's equations. 7

b. Given the electric potential field, $V = [A\rho^4 + B\rho^{-4}]\sin 4\phi$;

(i) Show that $\Delta^2 V = 0$ in cylindrical coordinates

(ii) Select the values of A and B, so that V = 100 V and $|E| = 500(V/m)$ at P(1, 22.5°, 2) 6

c. A large spherical cloud of radius, *b* has a uniform volume charge distribution of δ_V (c/m^3). Find the potential distribution and electric field intensity at any point in space using Laplace's and Poisson's equation. 7

UNIT - III

5 a. Derive the continuity equation of current in integral and point form. 6

Contd…2

b. Two cubes of dielectric materials have a common face in the *xy* - plane. An electric field vector, $E = 3a_x + 4a_y - 12a_z$ *(V/m)* in cube 2 ($z > 0$). The material of which has relative permittivity = 4. Find $\overline{D}$ in the cube 1, the material of which has relative permittivity = 2. 7

c. The Z = 0 plane defines the boundary between free space and a dielectric medium with a dielectric constant of 20. The E field next to the interface in free space is $E = 10a_x + 20a_y + 40a_z$ (V/m). Determine E on the other side of the boundary. 7

6 a. Discuss the boundary conditions between two dielectric medium interfaces. 8

b. Determine the capacitance of a parallel plate capacitor consisting of two parallel conducting plates of area 'A' and separation'*d*'. 6

c. Consider two metallic spherical shells of radii *a* and *b*. Find the capacitance of the system. 6

UNIT - IV

7 a. State Biot-Savarot's law. Derive the expression for magnetic flux density at a given point due to a current carrying element of finite length. 6

b. A straight conductor of length 2L carrying AC current of I coinsides with a_2 direction. Obtain the expression for the magnetic vector potential at a point in the bisecting plane of the conductor. Also find B at that point. 7

c. State and Prove Stoke's theorem. 7

8 a. State and Prove Ampere's Law. 7

b. Find the magnetic field due to an infinitely long straight conductor carrying a steady current of I(A). 7

c. A 10(A) current flows along a wire of length 10 (metres). If the wire is situated along the Z-axis of rectangular coordinate system and centered at the origin. Find the magnetic flux density at,

i) (0, 3, 0)

ii) (0, 0, 5) 6

UNIT - V

9 a. If the electric field intensity in free space is given in the rectangular coordinates as $E = E_m \sin\alpha x \sin(wt - \beta z)\overset{n}{a}_y \left(V/m\right)$. Find the magnetic field intensity, *H* using Faraday's law. 6

b. State and explain Faraday's law of electromagnetic induction. Write the point form of it. 8

c. Write Morewell's equation in integral form. 6

10 a. Find the self inductance per unit length of an infinitely long solenoid. 6

b. The dry earth has a conductivity, $\sigma = 10^{-8}$ (s/m) and a relative permittivity, $\in_r = 4$. Find the frequency range on which the conduction current dominates the displacement current. 6

c. Derive the expression for force between two current carrying conductors. 8

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