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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 - 2018

Electromagnetic Theory

Time: 3 hrs *Max. Marks: 100*

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

UNIT - I

1 a. A charge of $Q_1 = 3 \times 10^{-4}$ C is located at P(1, 2, 3) and a change $Q_2 = 10^{-4}$C is located at Q(2, 0, 5) in a vacuum . Find the vector force on charge Q_1 in component form. 6

b. Derive the expression for electric field intensity at a point due to a sheet of charge. 7

c. Find the electric field intensity at P (1, 1, 1) caused by four identical point charges each of 3 nc located at $P_1(1, 1, 0)$, $P_2(-1, 1, 0)$, $P_3(-1, -1, 0)$ and $P_4(1, -1, 0)$. 7

2 a. Assuming uniform line change distribution of ρ_l (c/m) lying along the Z-axis and extending from $-\infty$ to $+\infty$, use Gauss's law to find electric field intensity. 7

b. Starting from fundamental state and prove Gauss's divergence theorem. 8

c. Find the volume charge density at (4m, 45º, 60º), if $D = ra_r + \sin\theta a_\theta + \sin\theta\cos\phi a_\phi$º, c/m^2. 5

UNIT - II

3 a. Derive the expression for energy expended in moving a point charge in an electric field. 7

b. An electrostatic field is given by $E = \left(\frac{x}{2} + 2y\right)ax + 2x\,ay; {}^{V}\!/_{m}$. Find the work done in moving point charge Q = - 20 µc from i) The origin to (4, 0, 0) m and ii) from (4, 0, 0) to (4, 2, 0) m. 6

c. Using the expression for energy density in static electric field, obtain the expression for capacitance of co-axial cable. 7

4 a. Obtain continuity equation for current. 6

b. Obtain the boundary conditions for the case of conductor free boundary. 7

c. A potential field is given by $v = x^2 + y^2 + z^2$; volts. Assuming point p(1, 1, 1) be located at a conductor-free space boundary, find the magnitude of : 7

i) V ii) E iii) E_n iv) E_t v) ρ_s.

UNIT - III

5 a. Two cubes of dielectric materials have a common interface in the *xy* – plane. An electric field vector, $E = 3ax + 4ay - 12az$; V/m in cube Z(z > 0), the material of which has a E_r of 4. Find the volume of D in cube 1, the material of which has a $E_r = 2$. 7

b. Derive the expression for capacitance of two concentric spherical conductors of inner and outer radii *a* and *b*, respectively. 7

Contd…2

c. An air condenser consisting of two parallel square plates of 50 cm side is charged to a voltage of 200 V with plate separation of 1mm. Calculate the work done in widening the plate separation to 1cm. Assume perfect insulation. 6

6 a. Starting from fundamental derive Laplace and Poisson's equation. 7

b. Determine whether or not the following potential fields set's by Laplace equation : 7

i) $V = \rho \cos\phi + z$ ii) $V = r \cos\theta + \phi$

c. State and prove uniqueness theorem. 6

UNIT - IV

7 a. State and Prove Biot-Savart's law. 7

b. Using Biot-Savart's law, determine magnetic field intensity at any point along the axis of a circular current loop. 7

c. A circuit carrying a direct current of 5 A from a regular hexagon inscribed in a circular of radius 1 m. Calculate the magnetic flux density at the centre of the hexagon. Assume the medium to be free space. 6

8 a. Explain the concept of scalar and vector magnetic potential. 6

b. Using Ampere's circuital law, find the magnetic field at any radial distance for the case of a solid cylindrical conductor of radius '*a*'. 7

c. The magnetic field, $H = 2\rho^2(z + 1)\sin^2\phi a_\phi$, verify strokes theorem for the portion of a cylindrical surface defined by $\rho = 2$, $\pi/4 < \phi < \pi/2$, $1 < z < 1.5$ and for its perimeter. 7

UNIT - V

9 a. Starting from Faraday's law of electromagnetic induction, prove that $\nabla XE = -\frac{\theta B}{\theta t}$. 7

b. Derive the expression for motional emf in a conductor. 7

c. A copper disc of 15 cms dia is located at the centre of a long solenoid of length 1meter and having a dia of 30 cms. The solenoid is wound with 1200 turns. The disc is arranged to rotate about an axis coincident with the axis of solenoid at 1800 rpm. Brushes are provided at the centre and at the edge of the disc. If the current in the solenoid is 2 A, What is the emf between the brushes? 6

10 a. Derive the expression for force per unit length between two parallel current carrying conductors. 6

b. Derive the expression for inductance of toroid. 6

c. Two homogeneous, linear, isotrophic material have interface at $x = 0$ in which there is a surface current, $k = 200\ a_z$; A/m. For $x < 0$, $\mu_{r1} = 2$ and $H_1 = 150\ a_x + 400\ a_y + 250\ a_z$; AT/m. Find; 8

i) H_z ii) B_R iii) α_1 iv) α_2

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