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10EE44

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. State and explain Coulomb's law in complete form. **(05 Marks)**

b. It is required to hold four equal point charges each in equilibrium at the corners of a square. Determine the point charge which must be located at the centre of the square. **(07 Marks)**

c. Evaluate both sides of divergence theorem for the volume enclosed by r = 2m, z = 0 and z = 10m. Given $D = \frac{10r^3}{4} ar\ c/m^2$. **(08 Marks)**

2 a. With usual notations prove that $E = -\nabla V$. **(06 Marks)**

b. Determine work-done in carrying a $-2\mu C$ charge from P_1 (2, 1, –1) to P_2(8, 2, –1) in a field $E = ya_x + xa_y$ v/m along the path i) $x = 2y^2$ ii) joining P_1 to P_2. **(08 Marks)**

c. The potential field $V = \frac{60\sin\theta}{r^2}$ volts. Determine : i) electric flux density ii) volume charge density iii) electric potential at (r = 3m, $\theta = 60°$, $\phi = 25°$). **(06 Marks)**

3 a. Derive Poisson's and Laplace equation. **(06 Marks)**

b. A potential field $V = x^2yz + Ay^3z$ volts is required to satisfy Laplace equation. What should be value of 'A'? With this value of A determine : i) Potential ii) Electric field at (2, 1, –1). **(05 Marks)**

c. Derive an expression for capacitance of a spherical capacitor. **(09 Marks)**

4 a. Use Ampere Law to determine magnetic field intensity H at P(2, 3, 5) due to an infinitely long conductor placed at x = 0, y = 0 and carrying a current of 50A along positive a_z direction. **(06 Marks)**

b. Evaluate the closed line integral of 'H' from P_1(5, 4, 1) to P_2(5, 6, 1) to P_3(0, 6, 1) to P_4(0, 4, 1) to P_1(5, 4, 1) using straight line segments, $H = 0.1y^3a_x + 0.4xa_y$. Also determine : i) Quotient of closed line integral of 'H' to area enclosed by the path
ii) $\nabla \times H$ at the centre of path. **(09 Marks)**

c. Compare scalar magnetic potential with sector magnetic potential. **(05 Marks)**

PART – B

5 a. Derive an expression for force between two infinitely long straight parallel conduction separated by distance of 'd' m between them. Assume that they are placed in air. **(06 Marks)**

b. A current element $10^{-4}a_z$ Am is located at (2, 0, 0) and another current element 10^{-6} $(a_x - 2a_y + 3a_z)$Am is located at (–2, 0, 0) both in free space. Find force exerted on second element by the first element. **(06 Marks)**

c. Determine inductance of a solenoid with 200 turns wound highly on a cylindrical core of length 60cm and diameter 6cm. derive the expression used. **(08 Marks)**

6 a. Starting from Faraday's law of electromagnetic induction derive the equation $\nabla \times E = \frac{-\partial B}{\partial t}$. **(06 Marks)**

b. List Maxwell's equations for both steady and time varying fields in point form and integral form. Mention laws that each equation demonstrates. **(08 Marks)**

c. Determine frequency at which conduction current density 'J' and displacement density are equal. Given conductivity $\sigma = 2 \times 10^{-4}$ s/m and $\varepsilon_r = 81$. **(06 Marks)**

7 a. For electromagnetic wave propagating in free space prove that $\frac{|\bar{E}|}{|\bar{H}|} = \eta$. **(08 Marks)**

b. A 50 GHz plane wave travelling in the medium has an amplitude $E_0 = 20$V/m. Determine : i) Phase velocity ii) Wavelength iii) Impedance. Given $\varepsilon_r = 2$ and $\mu_r = 5$. **(06 Marks)**

c. State and prove pointing theorem. **(06 Marks)**

8 a. Define the terms : i) Reflection co-efficient and
ii) Transmission coefficient.
Also bring out the relation between. **(08 Marks)**

b. Write a short note on SWR. **(05 Marks)**

c. In free space ($z \le 0$), a plane wave with $H = 10\cos(10^8 t - \beta z)a_x$ mA/m is incident normally on a lossless medium ($\varepsilon = 2\varepsilon_0$, $\mu = 8\mu_0$) in region $z \ge 0$. Determine reflected wave H_r, E_r and transmitted wave H_T, E_T. **(07 Marks)**

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