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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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