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10ES36

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

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. State vector form of Coloumb's law of force between two point charges and indicate the units of quantities in the equation. **(06 Marks)**

b. Point charges of 50 nC each are located at A(1, 0, 0), B(−1, 0, 0), C(0, 1, 0) and D(0,−1, 0) m. Find the total force on the charge at A and also find $\vec{E}$ at A. **(06 Marks)**

c. Given the field $\vec{D} = 6\rho\sin\left(\frac{1}{2}\phi\right)\hat{a}\rho + 1.5\rho\cos\left(\frac{1}{2}\phi\right)\hat{a}\phi$. Evaluate both sides of divergence theorem for the region bounded by $\rho = 2$, $\phi = 0$ and $\phi = \pi$, $z = 0$ and $z = 5$. **(08 Marks)**

2 a. Establish the relation $\vec{E} = -\nabla V$. **(06 Marks)**

b. A non uniform field, $\vec{E} = y\hat{a}_x + x\hat{a}_y + 2\hat{a}_z$ is given. Determine the work expended in carrying 2C from B(1, 0, 1) to A(0.8, 0.6, 1) along the shorter arc of the circle, $x^2 + y^2 = 1$, $z = 1$. **(06 Marks)**

c. Derive the boundary conditions at the boundary between conductor to free space. **(08 Marks)**

3 a. Verify whether $V = \frac{2\cos\phi}{r}$ at $P(0.5, 45°, 60°)$ satisfies Laplace's equation. **(06 Marks)**

b. State and prove uniqueness theorem. **(06 Marks)**

c. Using Laplace equation derive the capacitance of a co-axial cable. **(08 Marks)**

4 a. Using Biot-Savart's law, obtain magnetic field intensity due to an infinite length conductor carrying current I. **(06 Marks)**

b. Calculate vector current density at P(2, 3, 4) if $\vec{H} = x^2z\hat{a}_y - y^2x\hat{a}_z$. **(04 Marks)**

c. Consider the portion of sphere, with the surface at r = 4, $0 \le \theta \le 0.1\pi$, $0 \le \phi \le 0.3\pi$ and the closed path forming its perimeter composed of three circular arcs. Given $\vec{H} = 6r\sin\phi\hat{a}_r + 18r\sin\theta\cos\phi\hat{a}_\phi$, evaluate both sides of stoke's theorem. **(10 Marks)**

PART – B

5 a. Derive Lorentz force equation. **(04 Marks)**

b. Explain the concept of magnetic boundary conditions. **(08 Marks)**

c. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of 6 cm diameter. The length of the tube is 60 cm and the solenoid is in air. Derive the equation for L. **(08 Marks)**

6 a. Explain Faraday's law of electromagnetic induction and there from derive Maxwell's equation in differential and integral form. **(08 Marks)**

b. Within certain region $\varepsilon = 10^{-11}$ F/m and $\mu = 10^{-5}$ H/m. If $B_x = 2\times10^{-4}\cos 10^5 t \sin 10^{-3} y$ T. Find

(i) $\vec{E}$

(ii) Total magnetic flux passing through the surface x = 0, 0 < y < 40 m at t = 1 μs.

(iii) The value of closed line integral of $\vec{E}$ around the perimeter of the given surface. **(12 Marks)**

7 a. Starting from Maxwell's equation, derive wave equation in $\vec{E}$ and $\vec{H}$ for an uniform plane wave travelling in free space. **(12 Marks)**

b. State and explain Poynting theorem. **(08 Marks)**

8 a. A 1 MHz plane wave is propagating in fresh water where $\varepsilon_r' = 81$, $\epsilon_r'' = 0$, $\mu_r = 1$, Calculate (i) Phase shift constant (ii) Wavelength (iii) Phase velocity (iv) Intrinsic impedance (v) E_y and H_z, if amplitude of $\vec{E}$ is 0.1 V/m. The wave is traveling in x-direction. **(10 Marks)**

b. Derive an expression for reflection and transmission co-efficient of the uniform plane wave incident normally at the boundary with different dielectric. **(10 Marks)**

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