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10ES36

Third Semester B.E. Degree Examination, Aug./Sept. 2020
Field Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define electric field intensity. Derive an expression for electric field intensity due to infinite line charge. **(08 Marks)**

b. State and prove Gauss law. **(05 Marks)**

c. In free space, let $\vec{D} = 8xyz^4 a_x + 4x^2z^4 a_y + 16x^2yz^3 a_z$ P C/m^2

i) Find the total electric flux passing through the rectangular surface $z = 2$, $0 < x < 2$, $1 < y < 3$, in the Q_z direction

ii) Find $\vec{E}$ at P(2, –1, 3) **(07 Marks)**

2 a. Derive an expression for the energy density in the electrostatic field. **(08 Marks)**

b. An electric field is expressed in rectangular co-ordinate system by

$\vec{E} = 6x^2 a_x + 6y a_y + 4a_z$ V/m

Find :

i) V_{MN} if points M and N are specified by M(2, 6, –1) and N(–3, –3, 2)

ii) V_M if $V = 0$ at Q(4, –2, –35) **(06 Marks)**

c. Let the region $z < 0$ be composed of a uniform dielectric material for which $\epsilon_r = 3.2$, while the region $z > 0$ is characterized by $\epsilon_r = 2$. Let $\vec{D}_1 = -30a_x + 50a_y + 70a_z$ n C/m^2 and Find :

i) D_{N_1} ii) $\vec{D}_{t_1}$ iii) D_{t_1} iv) D_1 v) θ_1. **(06 Marks)**

3 a. The vector current density is given by

$\vec{J} = \frac{2}{r^2}\text{Cos}\theta a_r + 20e^{-2r}\text{Sin}\theta a_\theta - r\text{Sin}\theta\text{Cos}\theta a_\phi$ A/m^2

Find : i) $\vec{J}$ at $r = 3$, $\theta = 0$, $\phi = \pi$

ii) Total current passing through the spherical surface $r = 3$, $0 < \theta < 20$, $0 < \phi < 2\pi$ in the 'r' direction. **(07 Marks)**

b. From Gauss's law, derive Poisson's and Laplace's equations. **(05 Marks)**

c. The inner conductor of radius 'a' of a coaxial cable is held at potential V_0 while the outer conductor of radius 'b' is grounded. Determine :

i) Potential distribution between conductor

ii) The surface charge density on the inner conductor and capacitance per unit length using Laplacean equation. **(08 Marks)**

4 a. State and explain Ampere's law. **(05 Marks)**

b. Calculate the value of vector current density given $\vec{H} = x^2 z a_y + y^2 \times a_z$ A/m at P_A (2, 3, 4). **(05 Marks)**

c. A very long, straight conductor located along the Z axis carries a current 'I' in the Z direction. Obtain an expression for the magnetic vector potential at a point in the bisecting plane of the conductor. What is the magnetic flux density at that point? **(10 Marks)**

PART – B

5 a. Derive an equation for the force between two differential current elements. **(04 Marks)**

b. The field $\vec{B} = -2a_x + 3a_y + 4a_z mT$ is present in free space. Find the vector force exerted on a straight wire carrying 12A in the a_{AB} direction, given A(1, 1, 1) and B(2, 1, 1). **(08 Marks)**

c. Obtain boundary conditions at the interface between two magnetic materials. **(08 Marks)**

6 a. What do you mean by displacement current? Derive Maxwell's equation in point form from Ampere's law. **(08 Marks)**

b. List Maxwell's equation in point form and integral forms. **(08 Marks)**

c. Write a note on retarded potential. **(04 Marks)**

7 a. Define uniform plane wave. Derive the equations for uniform plane wave in free space. **(07 Marks)**

b. Discuss wave propagation in good conductors. **(07 Marks)**

c. For a lossy dielectric material having $\mu_r = 1$, $\epsilon_r = 48$, $\sigma = 20 S/m$. Calculate the attenuation constant, phase constant, and intrinsic impedance at a frequency of 16GHz. **(06 Marks)**

8 a. Write a note on Poynting theorem. **(10 Marks)**

b. An electromagnetic wave propagates in a dielectric medium with $\epsilon = 9\epsilon_0$ along the Z direction. It strikes another dielectric medium with $\epsilon = 4\epsilon_0$ at Z = 0. If the incoming wave has a maximum value of 0.1 V/m at the interface, and its angular frequency is 300M rad/sec, determine :

i) reflection coefficient
ii) The transmission coefficient
iii) The power densities of the incident reflected and transmitted waves. **(10 Marks)**

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