Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2151002 **Date: 05/05/2017**

Subject Name: Engineering Electromagnetics

Time: 02:30 PM to 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 Do as directed. **14**

1. Show that $\mathbf{A} = 4\mathbf{a_x} - 2\mathbf{a_y} - \mathbf{a_z}$ and $\mathbf{B} = \mathbf{a_x} + 4\mathbf{a_y} - 4\mathbf{a_z}$ are mutually perpendicular vectors.
2. "The electric field intensity at a point can be defined as a force exerted on unit positive charge." Justify the statement.
3. What do you mean by electrostatic shielding?
4. "The work done is depends on the path selected in electrostatic field." Justify the statement.
5. Gauss's law relates the electric field intensity E with volume charge density ρ_v at a point as _____. (Choose correct answer from the followings)
   (a) $\nabla \times E = \varepsilon_0\rho_v$ (b) $\nabla \times E = \rho_v/\varepsilon_0$ (c) $\nabla \cdot E = V\ \rho_v/\varepsilon_0$ (d) $\nabla \cdot E = \rho_v/\varepsilon_0$ (e) $E= -\nabla\cdot V$.
6. The plane y = 3 m contains a uniform charge distribution with density $\rho_s = 10^{-8}/6\pi$ C/m^2. Determine **E** at y = 4.37 m.
7. A positive divergence for any vector indicates _____.(Choose correct answer from the followings)
   (a) a sink (b) an electric flux density (c) a source (d) a volume charge density.
8. State properties of conductor (any three).
9. What do you mean by non-conservative field? Give suitable example of the same..
10. Give the statement of uniqueness theorem.
11. "The line integral of magnetic field intensity around any closed path is exactly equal to the constant DC current enclosed by that path." Justify the statement.
12. Find velocity of propagation for EM wave in fresh water having $\varepsilon_r = 78$.
13. Give the statement of Faraday's law.
14. What do you mean by loss tangent?

Q.2 Answer the followings.

(a) Determine the volume V of a region defined in a cylindrical co-ordinate system as $1 \le \rho \le 2$, $0 \le \varphi \le \frac{\pi}{3}$, $0 \le z \le 1$m. **03**

(b) A line charge over a ring of radius 'a' meter located in xy-plane at z = 0. Find the electric field intensity at any point on the z-axis. **04**

(c) Derive the expression for the field of a sheet of charge. What inference can you draw from this as far as parallel plate air capacitor is concern? **07**

OR

(c) For the field independent of cylindrical coordinate z, there is equation of stream line obtained by solving the differential equations $\frac{E\rho}{E\varphi} = \frac{1}{5\rho}\frac{d\rho}{d\varphi}$. Find the equation of line passing through the point (3, 30^0, 0) for the field **E** = 3ρ Cos2φ·$\mathbf{a_\rho}$ - 5ρ Sin2φ·$\mathbf{a_\varphi}$. **07**

Q.3

(a) "The electric flux passing through any closed surface is equal to the total charge enclosed by that surface." Justify and support your answer mathematically. **03**

(b) What do you mean by equipotential surface? Explain in detail potential difference and absolute potential. **04**

(c) Prove the divergence theorem for the region r≤ a (in spherical coordinate system) having **D** = $\frac{5r}{3}\mathbf{a_r}$. **07**

OR

Q.3

(a) Two dipoles with dipole moments -5·$\mathbf{a_y}$ nCm and 9·$\mathbf{a_y}$ nCm are located at points (0, -2, 0) and (0, 3, 0) respectively. Find the potential at the origin. **03**

(b) Explain in detail potential gradient and derive the expression E = - ∇V. **04**

(c) "The electric flux per unit volume leaving a very small volume unit is exactly equal to the volume charge density there." Justify and apply Gauss's law to differential volume element. **07**

Q.4

(a) Find the magnitude of **E** in a sample of silver having conductivity $\sigma = 6.17 \times 10^7$ S/m and $\mu_e = 0.0056$ m^2/v-s if (i) if the drift velocity is 1 mm/s, (ii) the current density is 10^7 A/ m^2 and (iii) the sample is a cube of side 3 mm carrying a total current of 80 A. **03**

(b) Find the expression for capacitance of a parallel plate capacitor containing two dielectrics with the dielectric interface parallel to the conducting plates. **04**

(c) Explain the boundary conditions for two perfect dielectric materials. **07**

OR

Q.4

(a) State usefulness of Poisson's and Laplace's equation and derives the expression for both of these. **03**

(b) Explain the continuity of current and derive the expression for point form of continuity equation $\nabla \cdot J = -\partial\rho_v/\partial t$. **04**

(c) Apply boundary condition between two different magnetic materials which are isotropic homogeneous linear materials with permeability's μ_1 and μ_2. **07**

Q.5

(a) "The line integral of the magnetic field intensity over a closed path is equal to the integral of curl of magnetic field intensity over the surface enclosed by the closed path." Justify and prove your answer mathematically. **03**

(b) What do you mean by skin effect? Explain with suitable example how depth of penetration is different for perfect, imperfect and conducting medium? **04**

(c)	Apply Ampere's circuital law to the infinitely long coaxial cable carrying uniformly distributed total current I in the center conductor and find the magnetic field intensity everywhere.	**07**

OR

Q.5

(a)	A uniform plane wave with E-field in x-direction and H-field y-direction propagating in perfect dielectric medium having intrinsic impedance η. Get the expressions for poynting vector and time average power density.	**03**
(b)	A point charge Q = - 40 nC is moving with velocity 6×10^6 m/s in a direction specified by the unit vector $-0.48\mathbf{a_x} - 0.6\mathbf{a_y} + 0.64\mathbf{a_z}$. Use Lorentz force equation and find force **F** if $\mathbf{E} = 2\mathbf{a_x} - 3\mathbf{a_y} + 5\mathbf{a_z}$ kV/m and $\mathbf{B} = 3\mathbf{a_x} - 2\mathbf{a_y} + 5\mathbf{a_z}$.	**04**
(c)	Enlist all four Maxwell's equations in point form and starting from Gauss law derive the Maxwell's equation $\nabla \cdot D = \rho_v$.	**07**

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