Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – WINTER 2013

Subject Code: 151002 Date: 04-12-2013

Subject Name: Engineering Electromagnetics

Time: 10.30 am - 01.00 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 **(a)** (i) Transform the vector $\mathbf{B} = y\mathbf{a}_x - x\mathbf{a}_y + z\mathbf{a}_z$ into cylindrical coordinates. **07**
(ii) Transform vector field $\mathbf{G} = (xz/y)\mathbf{a}_x$ into spherical components and variables.

(b) Derive the expression for the electric field **E** due to infinite sheet of charge having a uniform density of ρ_S C/m^2. **07**

Q.2 **(a)** State and derive following: **07**
(1) Maxwell's first equation for electrostatics, (2) Divergence theorem.

(b) Write a detailed note on potential gradient. **OR** **07**

(b) Derive the expression of curl. Also mention its physical interpretation. **07**

Q.3 **(a)** What are the characteristics of a good conductor? Determine boundary conditions at a boundary between a conductor and free space. **07**

(b) A slab of dielectric material has a relative dielectric constant of 3.8 and contains a uniform electric flux density of 8 nC/m^2. If the material is lossless, find: (a) E; (b) P; (c) the average number of dipoles per cubic meter if the average dipole moment is 10^{-29} C•m. **07**

OR

Q.3 **(a)** Derive the expression of following capacitors: (a) coaxial capacitor, (b) spherical capacitor, (c) isolated spherical capacitor, (d) parallel-plate capacitor having two dielectrics parallel to the plates. **07**

(b) Given the electric flux density, $\mathbf{D} = 0.3r^2\mathbf{a}_r$ nC/m^2 in free space: (a) find **E** at point $P(r = 2, \theta = 25^o, \varphi = 90^o)$; (b) find the total charge within the sphere $r = 3$; (c) find the total electric flux leaving the sphere $r = 4$. **07**

Q.4 **(a)** State and Explain Biot-Savart law. Derive an expression of magnetic field intensity for an infinitely long straight filament carrying a direct current I on the z axis from $-\infty < z < \infty$. **07**

(b) Write a detailed note on Magnetization and permeability. **07**

OR

Q.4 **(a)** A current filament carrying 15 A in the $\mathbf{a}_z$ direction lies along the entire z axis. Find H in rectangular coordinates at $P_A(20^{1/2}, 0, 4)$. **07**

(b) Explain Hall voltage and Hall effect and mention its uses. Also derive the equation for the force on a differential current element. **07**

Q.5 **(a)** Mention all four Maxwell's equations for steady fields. Using the concept of Faraday's law and displacement current modify them for time varying fields. **07**

(b) The electric field amplitude of a uniform plane wave propagating in the $\mathbf{a}_z$ direction is 250 V/m. If $\mathbf{E} = E_x\mathbf{a}_x$ and w = 1.00 Mrad/s, find: (a) the frequency; (b) the wavelength; (c) the period; (d) the amplitude of **H**. **07**

OR

Q.5 **(a)** Given the potential field, $V = 2x^2y - 5z$, and a point $P(-4, 3, 6)$, find following values at point P: the potential V, the electric field intensity **E**, the direction of **E**, the electric flux density **D**, and the volume charge density ρ_v. **07**

(b) Write a detailed note on skin effect and skin depth. **07**

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