

# CBCS SCHEME

15EC36

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## Third Semester B.E. Degree Examination, July/August 2021 Engineering Electromagnetics

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions.

- 1 a. State and explain Coulomb's law of force between two point charges and mention the units of quantities in the force equation. (06 Marks)  
b. Three equal charges of  $1 \mu\text{C}$  each are located at the three corners of a square of 10 cm side. Find the electric field intensity at the fourth vacant point of the square. (10 Marks)
- 2 a. A line charge  $\rho_L = 50 \text{ nC/m}$  is located along the line  $x = 2, y = 5$  in free space. Find  $\vec{E}$  at  $P(1, 3, -4)$ . (06 Marks)  
b. Derive the expression of electric field intensity due to infinite line charge. (10 Marks)
- 3 a. State and prove the Gauss's law. (10 Marks)  
b. Given the flux density  $\vec{D} = \frac{5 \sin \theta \cdot \cos \phi}{r} \hat{a}_r \text{ C/m}^2$ . Find (i) Volume charge density  
(ii) Total flux leaving the surface of spherical volume of radius 2 m. (06 Marks)
- 4 a. State and derive the expression of law of continuity of current. (07 Marks)  
b. An electric potential is given by,  
 $V = \frac{60 \sin \theta}{r^2} \text{ volt}$ . Find  $V$  and  $E$  at point  $P(3, 60^\circ, 25^\circ)$ . (06 Marks)  
c. Express  $\vec{\nabla} \cdot \vec{D}$  in three coordinate systems. (03 Marks)
- 5 a. Starting from Gauss's law in integral form, derive Laplace's and Poisson's equations. Write the Laplace equation in all the coordinate systems. (06 Marks)  
b. Determine whether or not the following vectors represent a possible electric field:  
 $\vec{E} = (12yx^2 - 6z^2x) \hat{a}_x + (4x^3 + 18zy^2) \hat{a}_y + (6y^3 - 6zx^2) \hat{a}_z$  (03 Marks)  
c. State and prove uniqueness theorem. (07 Marks)
- 6 a. State Biot-Savart law. Obtain an expression for magnetic field intensity for current element. (08 Marks)  
b. Explain the concept of scalar and vector magnetic potential and show that  
 $\vec{A} = \frac{\mu_0}{4\pi} \int \frac{\vec{J}}{r} dV$ . where  $\vec{A}$  = Vector magnetic potential and  $J$  = current density (08 Marks)
- 7 a. Write short notes on force between two differential current elements. (08 Marks)  
b. A point charge  $q = -60 \text{ nC}$ , is moving with a velocity  $6 \times 10^6 \text{ m/s}$  in the direction specified by unit vector  $(-0.48 \hat{a}_x - 0.6 \hat{a}_y + 0.64 \hat{a}_z)$ . Find the magnitude of the force on a moving charge in the magnetic field  
 $\vec{B} = (2 \hat{a}_x - 6 \hat{a}_y + 5 \hat{a}_z) \text{ mT}$ . (08 Marks)

- 8 a. Derive the expression for the boundary condition for the tangential component at the interface between two media with different permeabilities. (06 Marks)
- b. If  $\vec{B} = 0.5x\hat{a}_y$  T in a material for which  $\chi_m = 2.5$  find,  
(i)  $\mu_r$  (ii)  $\mu$  (iii)  $\vec{H}$  (iv)  $\vec{M}$  (v)  $\vec{J}$ . (10 Marks)
- 9 a. Write Maxwell equations in points form and integral form. (06 Marks)  
b. State and prove Faraday's law. (05 Marks)  
c. Given  $\vec{H} = H_m e^{j(\omega t + \beta z)} \hat{a}_x$  A/m in free space. Find  $\vec{E}$ . (05 Marks)
- 10 a. Derive the expression for Poynting's theorem. (10 Marks)  
b. Write the short notes on skin effect. (06 Marks)

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