

B.Sc. F.Y. (CBCS Pattern) Semester-II  
**USPHT03 - Physics Paper-I - Vector Analysis and Electrostatics**

P. Pages : 3

Time : Three Hours



**GUG/S/25/11590**

Max. Marks : 50

- Notes : 1. All questions are compulsory.  
2. Draw well labeled diagram wherever necessary.

- Given : i) Charge on electron  $e = 1.6 \times 10^{-19} \text{ C}$   
ii) Permittivity of free space  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{Nm}^2$   
iii)  $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 / \text{C}^2$   
iv)  $\frac{\mu_0}{4\pi} = 10^{-7}$

**Either :**

1. a) i) Define scalar and vector with examples. 3  
ii) Define curl of a vector field. Find the value of curl of a vector  $\vec{A}(x, y, z)$  in terms of Cartesian coordinates. Give the physical significance of curl of a vector. 5  
iii) If the vector  $\vec{A} = K(-y\hat{i} + x\hat{j})$ , calculate curl  $\vec{A}$ . 2

**OR**

- b) a) State Gauss divergence theorem and Stoke's theorem. 2½  
b) Define gradient of a scalar field and give its physical significance. 2½  
c) Define scalar product of two vectors. Show that  $\vec{A} \cdot \vec{B} = A_x \cdot B_x + A_y \cdot B_y + A_z \cdot B_z$  2½  
d) If  $\vec{A} = x^3z\hat{i} + 3y^2z^2\hat{j} - 4xyz^2\hat{k}$ , Find div  $\vec{A}$  at the point (2,-1,1). 2½

**Either :**

2. a) i) Define electric dipole and electric dipole moment. 2  
ii) What is electric dipole? Find the expression for electric field intensity due to an electric dipole at a point a) on axial line b) on equatorial line. Hence prove  $E_{\text{axial}} = 2 \times E_{\text{equatorial}}$ . 5  
iii) Calculate the intensity of electric field due to an electric dipole of dipole moment  $3.5 \times 10^{-10} \text{ coulomb-meter}$  at a distance of 1.5 meter from it on i) dipole axis and ii) Equatorial line. 3

**OR**

- b) a) Obtain an expression for torque acting on a electric dipole in uniform electric field. 2½
- b) Show that electric field is a negative gradient of potential. 2½
- c) Express Coulomb's law in vector form. Hence Show that  $F_{12} = -F_{21}$ . 2½
- d) A charge of Coulomb is located at  $(3\hat{i} + 4\hat{j} + 5\hat{k})$  m. Calculate the electric field intensity at a point having position vector  $(5\hat{i} + 4\hat{j} + 3\hat{k})$  m. 2½

**Either :**

3. a) i) State the Gauss's theorem of electrostatics and express it in differential form. 2
- ii) Derive an expression for electric field due to a uniformly charged spherical shell using Gauss's law at a point a) outside the shell b) on the surface of the shell c) inside the shell. 5
- iii) A hallow metallic sphere of radius 0.1 m has  $10^{-8}$  Coulomb of charge uniformly spread over it. Determine electric field intensity at point i) on the surface of the sphere ii) at point 7 cm away from the center and iii) at point 0.5 m away from the centre. 3

**OR**

- b) a) Obtain an expression for electric potential due to a point charge. 2½
- b) Apply Gauss theorem to calculate the electric field due to an infinitely long uniformly charged straight wire (infinite line charged) 2½
- c) Derive an expression for electric field due to a point charge. 2½
- d) The radius of nucleus of silver (atomic number  $Z = 47$ ) is  $3.4 \times 10^{-14}$  m. Calculate the electric potential of the surface of nucleus. 2½

**Either :**

4. a) i) Define capacity of a capacitor state its SI unit. 2
- ii) Give the construction and obtain an expression for capacity of a parallel plate capacitor completely filled with dielectric medium. 4
- iii) A parallel plate capacitor is filled with two dielectrics of same dimensions but different constant  $k_1$  and  $k_2$  respectively. Calculate its capacitance. 4

**OR**

- b) a) Distinguish between polar and non-polar molecules. 2½
- b) Obtain the relation between three electric vectors D, E and P. 2½
- c) Obtain the expression for parallel plate capacitor. 2½
- d) The plates of parallel plate capacitor are separated by 2mm. What must be the plate area if the capacitance to be 1F assuming that air is filled between the plates. 2½
- Given  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$

5. Attempt **any ten** of the followings.

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| a) Define del operator.  | 1 |
| b) What is irrotational.   | 1 |
| c) What is solenoidal.   | 1 |
| d) What are limitations of Coulomb's law.  | 1 |
| e) What is electric field? and write its unit.   | 1 |
| f) Define electric potential.  | 1 |
| g) Represent graphically the variation of Electric field intensity $E$ with distance $r$ due to the solid sphere.      | 1 |
| h) What is a Gaussian surface?   | 1 |
| i) A point charge $q$ is enclosed at the center of a cube of side $a$ . Find the electric flux through the whole cube. | 1 |
| j) What is dielectric substance? Give example.   | 1 |
| k) What is polarization?   | 1 |
| l) Define dielectric constant. State its unit and dimensions.  | 1 |

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