

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

P. Pages : 2

Time : Three Hours



**GUG/W/22/11590**

Max. Marks : 50

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

**1.** Either

- a) i) Define scalar product of two vectors. State its important properties. 3  
ii) Deduce the expression for scalar product of two vectors in terms of their rectangular components and obtain an expression for the angle between two vectors. 4  
iii) If  $\vec{A} = (3\hat{i} + 4\hat{j} - 5\hat{k})$  and  $\vec{B} = (\hat{i} - 2\hat{j} + 3\hat{k})$  Find (a)  $\vec{A} + \vec{B}$  (b)  $\vec{A} - \vec{B}$  (c)  $\vec{A} \times \vec{B}$  3

**OR**

- b) 1) Define gradient of a scalar field in cartesian co-ordinates. Explain its physical significance. 2½  
2) Show that scalar product of two perpendicular vector is zero. 2½  
3) Explain line integral of a vector field along the curve and give one example of the line integral. 2½  
4) If  $\phi$  is any scalar then Prove that  $\text{curl grad } \phi = 0$ . 2½

**2.** Either

- a) i) State Coulomb's law for electrostatic force between two charges. Does this force depend on the medium between the charges? 3  
ii) Obtain an expression for the electric field due to a electric dipole at a point 5  
a) On the axial line                      b) On the equatorial line  
iii) Find the magnitude of the isolated positive point charge which can produce an electric potential of 18 volts at a distance 10cm from the charge. 2

**OR**

- b) 1) Find an expression for electric field intensity due to a point charge. 2½  
2) Obtain an expression for work done in rotating an electric dipole in an electric field. 2½  
3) Obtain an expression for torque on a dipole in an uniform electric field. 2½  
4) Prove that the electric field by  $\vec{E} = \hat{i}x + \hat{j}y + \hat{k}z$  is conservative. 2½

**3.** Either

- a) i) Write down the integral form of Gauss law and derive Coulomb's law from it. 3  
ii) Using Gauss's theorem, derive an expression for electric field intensity due to uniformly charged non-conducting solid Sphere at points. 5  
a) Outside the sphere  
b) Surface on the sphere  
c) Inside the sphere

- iii) A sphere of radius 5cm, has a point charge,  $Q = 17.7\mu\text{C}$ , located at its centre. Find the electric flux through the surface. ( $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{N} \cdot \text{m}^2$ ) 2

**OR**

- b)
- 1) Prove that the electric field on the surface of charged conductor is  $\frac{\sigma}{\epsilon_0}$ . 2½
  - 2) Obtain an expression for electric Potential due to a point charge. 2½
  - 3) Using Gauss theorem obtain an expression for electric field intensity due to an infinite plane sheet of charge. 2½
  - 4) A thin spherical shell of radius 0.25m is uniformly charged to  $0.2\mu\text{C}$ . Calculate the electric field intensity at a point 3.0 meter from the centre of spherical shell. 2½

**4.** Either

- a) i) What is a capacitor? Define capacitance of a capacitor. 2
- ii) Obtain an expression for the capacitance of a Parallel Plate capacitor when Partly filled with a dielectric substance. 5
- iii) A capacitor of capacitance  $40\mu\text{F}$  is charged to a Potential 1000 Volt. Calculate the energy stored in the capacitor. 3

**OR**

- b) 1) Derive an expression for the capacitance of a spherical condenser with air. 2½
- 2) Explain Polar and non-Polar dielectric with example. 2½
- 3) Obtain an expression for energy per unit volume in electric field. 2½
- 4) A Parallel Plate capacitor of two plates of area  $2\text{m}^2$ . The space between the plate is 1 mm and filled with a dielectric of relative permittivity of 7. Calculate the capacitance of capacitor ( $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{N} \cdot \text{m}^2$ ). 2½

**5.** Solve **any ten** of the following.

- a) Define unit vector. 1
- b) Define divergence of a vector. 1
- c) Define cross product of a vector. 1
- d) Define electric Potential. 1
- e) What is an electric dipole? 1
- f) What is conservative electric field? 1
- g) What is Gaussian surface? 1
- h) Define dielectric material. 1
- i) State the equation for electric Potential at any point due to dipole. 1
- j) Define electric field intensity. 1
- k) Define capacitance of spherical capacitor. 1
- l) Define Polarizability of dielectric. 1

\*\*\*\*\*