

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

P. Pages : 3

Time : Three Hours



**GUG/W/24/11590**

Max. Marks : 50

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

**Either:**

1. a) i) Define vector product of two vectors. State its important properties. 3  
ii) Define curl of vector field and give it's physical significance. 4  
iii) Find  $\vec{A} \cdot \vec{B}$  and angle between the vectors  $\vec{A} = 2\hat{i} + 2\hat{j} + 3\hat{k}$  and  $\vec{B} = 6\hat{i} - 3\hat{j} + 2\hat{k}$ . 3

**OR**

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

**Either:**

2. a) i) Define electric field and electric field intensity. 2  
ii) What is electric dipole moment? Find the expression for electric field intensity due to an electric dipole at a point (a) on axial line (b) on equatorial line. 5  
iii) Calculate the electric field due to a electric dipole of dipole moment  $4.5 \times 10^{-10} \text{ C-m}$  at a distance 1 meter from it (i) on its axis and (ii) on its perpendicular bisector. 3

**OR**

- b) a) Obtain an expression for torque on a dipole in an uniform electric field. 2½  
b) What do you mean by conservative field? Show that electrostatic field is conservative. 2½

- c) Show that electric field is a negative gradient of electric potential. 2½
- d) The electric potential in a region is given by;  $V = 4x^2 - 3y^2 - 9z^2$ . Find the electric field at a point (3,4,5) in this region. 2½

**Either:**

3. a) i) State Gauss's theorem of electrostatics. 1
- ii) Using Gauss's theorem, Derive an expression for electric field due to a uniformly charged spherical shell at point (1) outside the shell, (2) inside the shell and (3) on the surface of the shell. 6
- iii) A spherical shell of radius 0.3 m has  $10^{-8}$  Coulomb uniformly spread over it. Determine electric field intensity at a point (a) outside a sphere 3 m from the centre of shell (b) on the surface of shell (c) at a distance 8 cm from the centre of the shell. 3

**OR**

- b) i) On using Gauss's theorem, derive an expression for the electric field at infinitely long line of charge having uniform charge density of  $\lambda$ . 2½
- ii) Using Gauss's theorem find electric field intensity due to infinite plane of sheet of charges. 2½
- iii) Derive an expression for electric field due to a point charge. 2½
- iv) Calculate the electric flux due to point charge of magnitude 8.85 C which is closed inside a cube. 2½

**Either:**

4. a) i) What is capacitor? Define capacitance of a capacitor. 2
- ii) Obtain an expression for capacitance of a parallel plate capacitor when a dielectric slab partially fills the space between plates. 5
- iii) The area of each plate of a capacitor is  $10^9 \text{ m}^2$ . What will be the separation between the plate if the capacitance is 1 farad, assuming the air is filled between the plates? 3

**OR**

- b) i) What are polar and non-polar molecules? Give examples. 2½
- ii) Explain three electric vectors: (1) Polarization Vectors (2) Electric Displacement Vector (3) Electric field intensity. 2½

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|------|--|----|
| iii) | Establish the relation between three electric vectors E, D and P.  | 2½ |
| iv)  | Find the area of the plate used in the condenser of capacity 0.002 μF . If the dielectric constant of paper is 2.5 and thickness is 0.05 mm. | 2½ |

5. Answer **any ten** questions of the followings.

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|----|---|---|
| a) | What is unit vector?  | 1 |
| b) | State any two properties of scalar product.   | 1 |
| c) | Define scalar and vector quantities.  | 1 |
| d) | Explain electric quadrupole?  | 1 |
| e) | What is electric dipole?  | 1 |
| f) | Explain flux of electric field & state its SI unit.   | 1 |
| g) | What is a Gaussian surface?   | 1 |
| h) | Define electric potential and write its SI unit.  | 1 |
| i) | A sphere of radius 5 cm, has a point charge $q = 17.7 \mu\text{C}$ , located at its centre.<br>Find Electric flux through the surface. ( $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2\text{N}^{-1}\text{m}^{-2}$ ). | 1 |
| j) | What are dielectric materials?  | 1 |
| k) | Define dielectric polarization.   | 1 |
| l) | What is dielectric constant?  | 1 |

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