Bachelor of Science (F.Y. B.Sc.) (CBCS Pattern) Second Semester CBCS USPHT03 - Physics Paper-I (Vector Analysis and Electrostatics)

P. Pages: 3

Time : Three Hours

GUG/W/18/11590

Max. Marks : 50

3

2

2¹/₂

 $2^{1/2}$

Notes : 1. All questions are compulsory.

2. Draw neat labelled diagrams wherever necessary.

Given constants:

- i) Charge on electron $e = 1.6 \times 10^{-19} C$
- ii) Permittivity of free space $\in_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{ Nm}^2$

iii)
$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 / \text{C}^2$$

iv)
$$\mu_0 = 4\pi \times 10^{-7}$$

Either

- **1.** A) i) Define scalar and vector with examples.
 - ii) Define divergence of a vector. Give the physical significance of divergence to show divergence of any vector field at a point within small volume is equal to net outward flux per unit volume.

iii) Find the divergence of a vector
$$\overrightarrow{A} = (xy \ i + yz \ j + zx \ k)$$
 at a point (1, 1, -1).

OR

B)

- a) Define scalar product of two vectors. Show that $\overrightarrow{A} \cdot \overrightarrow{B} = Ax \cdot Bx + Ay By + Az Bz$.
- b) Calculate the area of a parallelogram whose adjacent sides are given by vectors $2\frac{1}{2}$ $\overrightarrow{A} = (i + j + k)$ and $\overrightarrow{B} = (2i - j + 3k)$
- c) Define gradient of a scalar field and given its physical significance. $2^{1/2}$
- d) Define curl of a vector and show that

$$\operatorname{Curl} \overrightarrow{A} = \begin{vmatrix} \overrightarrow{i} & \overrightarrow{j} & \overrightarrow{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ Ax & Ay & Az \end{vmatrix}$$

Either

- **2.** A) i) Define electric dipole and electric dipole moment.
 - ii) Obtain an expression for electric field intensity at a point due to the short electric **6** dipole. Hence show that for a point at same distance from the center of dipole, $E_{axis} = 2E_{equ}$.

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iii) Electric potential in a space is given by V = (3x + 4y - 7z). Find the electric field 2 intensity.

OR

B)	a)	Obtain an expression for torque acting on an electric dipole placed in a uniform electric field.	21/2		
	b)	Derive an expression for potential energy of an electric dipole in an uniform electric field.	2 ¹ / ₂		
	c)	Show that $E = -$ grad V.	2½		
	d)	Two charges +1.5µC and -1.5µC are separated by a distance 1.5mm to form a electric dipole. Find i) Electric dipole moment ii) Electric field intensity at a distance 20cm on the dipole axis.			
	Eith	ner			
A)	i)	Using Gauss's theorem find the electric field intensity due to the uniformly charged spherical shell at pointa) Out side the spherical shell.b) On the surface of the spherical shell.	5		
	ii)	Derive an expression for electric field due to a plane charged sheet using Gauss theorem.			
	iii)	A point charge of 14C is located at the center of cube of the side 7cm. Find the electric flux througha) Whole surface of cubeb) Each face of cube	2		
		OR			
B)	a)	State Gauss's theorem in electrostatics. Show that Coulomb's law of electrostatics is a special case of Gauss's theorem.	21/2		
	b)	Find the electric field on the surface of charged conductor of any shape.	21/2		
	c)	Obtain an expression for electric potential due to a point charge.	2¹/ ₂		
	d)	Calculate the electric flux through the surface $\overrightarrow{S} = 10$ i in the region of electric field	21/2		

 $\overrightarrow{E} = (2 \overrightarrow{i} + 3 \overrightarrow{j} + \overrightarrow{k})$. What will be the charge enclosed by above surface?

3.

Either

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4.	A)	i)	Give the construction and obtain an expression for capacity of a parallel plate capacitor completely filled with dielectric medium.	3
		ii)	Obtain an expression for energy per unit volume of a capacitor.	3
		iii)	A parallel plate capacitor is filled with two dielectrics of same dimensions but different dielectric constants K_1 and K_2 . Find the capacity of a capacitor with combination of two dielectrics.	4
			OR	
	B)	a)	Distinguish between polar and non-polar molecules.	21/2
		b)	Explain capacitance of an isolated spherical conductor.	21/2
		c)	Explain the polarization of dielectric medium.	21/2
		d)	Calculate the capacity of the earth assuming it to be a spherical conductor of radius 6400km.	21/2
5.		Atte	empt any ten of the following.	1
		a)	what is volume integral of vector field?	1
		b)	State Gauss-divergence theorem.	1
		c)	State Stoke's theorem of vectors.	1
		d)	Define electric field and electric potential.	1
		e)	What is mean by electric quadrupole?	1
		f)	The total electric flux through the closed surface surrounding a dipole.	1
		g)	State the Gauss theorem in the integral form.	1
		h)	State the equation for electric potential at a point due to short electric dipole.	1
		i)	Represent graphically the variation of potential v with distance r due to the solid sphere.	1
		j)	Define dielectric constant. State its unit and dimensions .	1
		k)	Define atomic polarizability.	1
		l)	State the equation for a capacity of spherical capacitor filled with dielectrics.	1
