USPHT03 - Physics Paper-I (Vector Analysis and Electrostatics)

P. Pages : 3

Time : Three Hours

GUG/W/23/11590

Max. Marks : 50

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

Either:

1. a) i) Define scalar and vector with examples. **2**

ii) Derive the expression for volume of parallelopiped. **4**

iii) If $\vec{A} = \hat{i} - 3\hat{j} + \hat{k}$, $\vec{B} = 2\hat{i} - 4\hat{j} + 2\hat{k}$ and $\vec{C} = \hat{i} - 3\hat{j} - 2\hat{k}$ are sides vectors of parallelogram, find volume of parallelogram. **2**

iv) Which of the following Vector is Solenoidal vector. **2**

1) $\vec{A} = x\hat{i} + y\hat{j} + z\hat{k}$ 2) $\vec{D} = y\hat{i} + z\hat{j} + x\hat{k}$

OR

b) a) Define divergence of a vector field. Explain its physical significance. **2½**

b) State Gauss divergence and Stoke's theorem. **2½**

c) Explain the meaning of
   a) Line integral   b) Surface integral   c) Volume integral **2½**

d) Find the directional derivatives if $\phi = x^2 + 3xyz - z^2$ at (1,4,1) **2½**

Either:

2. a) i) Define Electric Field lines of forces. **1**

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. Hence prove $E_{axial} = 2E_{equitorial}$. **6**

iii) Two charges of 25 nC and -25 nC are placed 10 cm apart. Calculate the intensity of electric field at a point 4 m from the centre of electric dipole on (a) axial line (b) equatorial line (Given $1/4\pi\varepsilon_0 = 9 \times 10^9 \, Nm^2/C^2$). **3**

OR

b) a) Derive an expression for Torque on an Electric dipole in an Uniform Electric Field. **2½**

b) Explain the Conservative nature of Electric Field. **2½**

c) Derive an expression for Potential energy of an Electric Dipole. **2½**

d) Calculate the force on +20 C if two charges +10 C and +20 C are located at points (1,-6,3) and (-3,2,0) meter. (Given $1/4\pi\varepsilon_0 = 9 \times 10^9\,\text{Nm}^2/\text{C}^2$) **2½**

Either:

3. a) i) Give the significance of the Gauss's law of electrostatics. **1**

ii) Derive an expression for electric field due to a uniformly charged Spherical Shell using Gauss's law, at a point a) outside the Spherical Shell b) on the surface of the Spherical Shell c) inside Spherical Shell. **7**

iii) Estimate the electric potential due to an electric dipole with dipole moment 1.67×10^{-27} Cm on a point P which is located at distance 0.01 cm. (Given $\varepsilon_0 = 8.85 \times 10^{-12}\,\text{C}^2/\text{Nm}^2$) **2**

OR

b) a) Using Gauss theorem obtain an expression for electric field intensity due to an infinite charge conductor. **2½**

b) Derive expression for the electric field due to Point Charge by using Gauss theorem. **2½**

c) Explain the meaning of a) Linear Charge Density b) Surface Charge Density and c) Volume Charge Density. **2½**

d) Calculate the electric potential Gradient and electric field intensity, if electric potential in space is given by V = 2x + 5y - 8z. **2½**

Either:

4. a) i) Explain classification of dielectrics. **2**

ii) Derive expression for capacitance of Parallel Plate Capacitor Partially filled with a dielectric medium. **4**

iii) Obtain an expression for capacitance of Cylindrical Condensor. **2**

iv) Find the amount of charge stored on either plate of a capacitor 4×10^{-6} F when connected across a 12V battery. **2**

OR

b) a) Obtain an expression for capacitance of a Parallel Plate Capacitor. **2½**

b) Explain polarization vector and electric displacement vector. **2½**

c) Derive an expression for energy per unit volume of a charged capacitor. **2½**

d) A spherical capacitor has an inner radius of 7 cm and an outer radius of 10 cm. Find the capacitance of sphere. Assume that dilectric in between to be air. **2½**

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

    a)   Define Irrotational vector.   **1**

    b)   Give two properties of Vector Product.   **1**

    c)   What is gradient of scaler?   **1**

    d)   What is dimension electric potential.   **1**

    e)   Define electric field intensity.   **1**

    f)   What is properties of electric charge?   **1**

    g)   What is electric field when a Gaussian surface encloses no net charge?   **1**

    h)   State Gauss theorem in differential form.   **1**

    i)   What is the value electric field intensity inside spherical shell? And why?   **1**

    j)   Define Electric Susceptibility.   **1**

    k)   Define atomic Polarizability.   **1**

    l)   What is unit of dielectric Polarization?   **1**

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