Mahindra University Hyderabad

École Centrale School of Engineering

Minor-I exam

Program: B. Tech. **Branch: ALL Year: II** **Semester: I (Fall 2024)**

Subject: PHYSICS-II (PH 2102)

Date: 11-09-2024 **Start Time: 2:00 to 3:30 PM**

Time Duration: 1.5 Hours **Max. Marks: 40**

Instructions:

1) Answer all the questions.

2) Important: Answer all parts of a given question together. Otherwise, they won't be evaluated!

3) All the best!

Q 1.

a) The temperature in a *greenhouse* is given by the function $T = 3x^2 + 2y^2 - 5z$. A butterfly is located at a point, whose coordinate is (2, -1, 3) in the greenhouse and wishes to fly in a direction that will make it warmer as quickly as possible. In what direction must the butterfly fly?

b) Using *Gauss Divergence theorem*, evaluate the surface integral $\int_S (3x\,\hat{x} + 2xy\,\hat{y}) \cdot d\vec{A}$ over the area defined by the sphere $x^2 + y^2 + z^2 = 4$.

c) Write two charge configurations that follow Dirac delta distribution in space.

(4+5+3 = 12 marks)

Q 2.

a) There are two charges $+Q$ and $+2Q$ located at points $A\ (0, b, 0)$ and $B\ (0, 3b, 0)$ on the y-axis. Calculate the resultant force acting on a charge $+3Q$ at the point $P\ (0, 0, a)$ on the z-axis.

b) The electric field in a region is given by $\vec{E} = xy\,\hat{x} + x^2\,\hat{y}$. Find the corresponding volume charge density ρ.

(5 + 4 = 9 marks)

Q 3.

a) Find the field inside and outside a long hollow cylindrical tube of radius s, which carries a uniform surface charge, σ.

b) In Cartesian coordinate system a point is defined as $\left(\frac{1}{2}, \frac{\sqrt{3}}{4}, 5\right)$. Convert this into cylindrical coordinates.

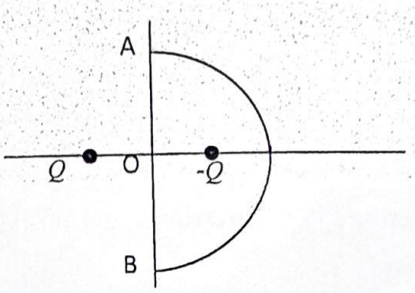
(5 + 3 = 8 marks)

Q4.

a) A pair of point charges $+Q$ and $-Q$ are placed at a separation d as shown in the figure.

i) What will be the value of $\overline{\nabla}.\ \overline{E}$ at the point O midway between the charges?

ii) What will be the value of $\int_A^B \overline{E}\ .\ \overline{dl}$ along a semi-circular path C of radius d as shown in figure?



b) Given the potential $V = \frac{1}{r^2}\sin\theta\cos\varphi$. Find the electric field at $\left(2, \frac{\pi}{2}, 0\right)$.

(3 + 4 + 4 = 11 marks)