Course: PYL 111
Minor-1

Marks: 20 Time: 1 hour

Answer all questions:

1. (a) Find the potential of a uniformly charged spherical shell of radius R.

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(b) A long cylinder carries charge density that is proportional to the distance from the axis $\rho=ks$, for some constant k. Find the electric field inside this cylinder.

2

2. (a) Explain and deduce the differential form of Gauss's law.

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(b) Find the potential at a distance s from an infinitely long straight wire that carries a uniform line charge λ. Compute the gradient of your potential, and check that it yields the correct field.

3

3. (a) A sphere of radius R, centered at the origin, carries charge density

$$\rho(r,\theta) = k\frac{R}{r^2}(R-2r)\sin\theta\,;$$

where k is a constant, and (r, θ) are usual spherical coordinates. Find the approximate potential for points on the z-axis, far from the sphere.

3

(b) Show that the electric field of a perfect dipole can be written in coordinate free form

$$\vec{E}_{dip} = \frac{1}{4\pi\varepsilon_0}\frac{1}{r^3}[3(\vec{p}.\hat{r})\hat{r} - \vec{p}]$$

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4. (a) State and prove first and second uniqueness theorems.

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(b) Discuss if the potential in a volume is uniquely determined if (a) charge density throughout the region and (b) the value of V at the boundaries is specified.

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