

Phys 3010 Mathematical Physics

Assignment 5

1. Consider the point (in Cartesian Coordinates) given by (4,-2,6).
 - a. What is this point in Cylindrical Polar Coordinates?
 - b. What is the radial unit vector at that point?
2. There is a charge of uniform density $\lambda = \lambda_0 \cos^2\varphi$ on the quarter circle in the x-y plane with a radius a, $x>0$, and $y>0$. Find the total charge.
3. A cylinder of radius 0.08 m is 0.4 m long. (Take the axis of the cylinder to be the z axis, with the origin at one end.) Inside the cylinder there is a charge distributed through the cylinder. Find the total charge ($\int \rho \, dv$) if the charge density (ρ) is
 - a. $5 \mu\text{C}/\text{m}^3$
 - b. $r^5 \cos(\varphi) \mu\text{C}/\text{m}^3$
4. There is an electric field given by $\mathbf{E} = E_0 x/a \mathbf{i}$. Calculate the flux ($\int \mathbf{E} \cdot d\mathbf{A}$) crossing the curved surface of a half cylinder of radius a with $-\frac{1}{2}\pi \leq \varphi \leq \frac{1}{2}\pi$ and $0 \leq z \leq L$.
5. A solid cylinder is defined by the y-z plane and the curved surface of radius a with $-\frac{1}{2}\pi \leq \varphi \leq \frac{1}{2}\pi$ and $0 \leq z \leq L$. It contains mass with a uniform density, such that the total mass is M. It is made to rotate about the z-axis. Find its moment of inertia (in terms of M and a)
 - a. If the density is uniform
 - b. If the density varies as $\rho = \rho_0 (2a-x)/a$
 - c. Bearing in mind the result of 5a, is your result from 5b reasonable? (Explain briefly)
6. (Extra credit) Repeat question 5b if the axis is moved to be the line which is parallel to the z axis, but which runs through the point $(x,y,z) = (a,0,0)$