Department of Physics, Shiv Nadar Institution of Eminence
Spring 2025
PHY102: Introduction to Physics-II
Tutorial – 4

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1. Evaluate the following integrals:

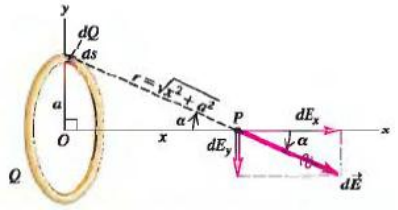
(a) $\int_{\text{all space}} (r^2 + \mathbf{r}\cdot\mathbf{a} + a^2)\delta^3(\mathbf{r}-\mathbf{a})\,d\tau$, where $\mathbf{a}$ is a fixed vector and a is its magnitude.

(b) $\int_{\mathcal{V}} |\mathbf{r}-\mathbf{b}|^2\delta^3(5\mathbf{r})\,d\tau$, where $\mathcal{V}$ is a cube of side 2, centered on the origin, and $\mathbf{b} = 4\,\hat{\mathbf{y}} + 3\,\hat{\mathbf{z}}$.

(c) $\int_{\mathcal{V}} (r^4 + r^2(\mathbf{r}\cdot\mathbf{c}) + c^4)\delta^3(\mathbf{r}-\mathbf{c})\,d\tau$, where $\mathcal{V}$ is a sphere of radius 6 about the origin, $\mathbf{c} = 5\,\hat{\mathbf{x}} + 3\,\hat{\mathbf{y}} + 2\,\hat{\mathbf{z}}$, and c is its magnitude.

(d) $\int_{\mathcal{V}} \mathbf{r}\cdot(\mathbf{d}-\mathbf{r})\delta^3(\mathbf{e}-\mathbf{r})\,d\tau$, where $\mathbf{d} = (1, 2, 3)$, $\mathbf{e} = (3, 2, 1)$, and $\mathcal{V}$ is a sphere of radius 1.5 centered at (2, 2, 2).

2. A ring shaped conductor with radius *a* carry a total charge *Q* uniformly distributed around it (see Figure below). Find the electric field at a point *P* that lies on the axis of the ring at a distance *x* from its centre. Also, what is the electric field at the centre of the ring? What will happen if *x*>>*a*? Given the infinitesimally small segment (*ds*) on the ring with charge *dQ* acts as a point charge source for electric field.



3. Positive charge *Q* is distributed uniformly throughout the volume of an insulating sphere with radius *R*. Find the magnitude of the electric field at a point *P* a distance *r* from the centre of the sphere.

4. Find the electric field a distance z above the center of a flat circular disk of radius R that carries a uniform surface charge σ. What does your formula give in the limit $R \to \infty$? Also check the case $z \gg R$.