Homework #2 (10 points) - Show all work on the following problems:

**Problem 1 (2 points):** Evaluate the following volume integrals.

a. \[ \iiint (r^2 + r \cdot \vec{d} + a^2) \delta^3 (r - \vec{a}) \, dV \] over all space (\( \vec{d} \) is a fixed vector of magnitude \( a \))

b. \[ \iiint (r^4 + r^2 \cdot \vec{e} + e^4) \delta^3 (r - \vec{e}) \, dV \] over a spherical volume with radius 6 centered at the origin, for the vector \( \vec{e} = 5\hat{x} + 3\hat{y} + 2\hat{z} \).

**Problem 2 (3 points):** Take the vector functions \( \vec{F}_1 = x^2 \hat{z} \) and \( \vec{F}_2 = x\hat{x} + y\hat{y} + z\hat{z} \).

a. Calculate the divergence and curl of each one of these functions.

b. Which one can be written as the gradient of a scalar function? For this one, find a scalar function that has the right gradient.

c. Which one can be written as the curl of a vector function? For this one, find a vector function that has the right curl.

**Problem 3 (3 points):** Find the vector electric field a distance \( z \) above the center of a circular loop of radius \( R \) that carries a uniform line charge density \( \lambda \).

**Problem 4 (2 points):** Find the vector electric field a distance \( z \) above the center of a flat circular disk of radius \( R \) that carries a uniform surface charge density \( \sigma \).