1. Given the force field \( \mathbf{F} = \mathbf{i} + 2\mathbf{j} - t\mathbf{k} \) and the parametric equations
\[
\begin{align*}
x &= 3\cos\sqrt{t} \\
y &= 3\sin\sqrt{t} \\
z &= 4\sqrt{t}
\end{align*}
\]
of a curve \( C \), where \( 0 \leq t \leq \pi^2 \), find the work over the curve \( C \).

2. For each of the following force fields that are path-independent, find the corresponding potential function:
   (a) \( \mathbf{F} = -y\mathbf{i} + x\mathbf{j} \); (b) \( \mathbf{F} = (x^3 - 3xy^2, y^3 - 3x^2y) \).

3. For each of the force fields in Problem 4 that are not path-independent, find the work done over the circle of radius 2 centered at point \((0,1)\). Do this in two ways: (i) using Green’s theorem and (ii) without using it.

4. Find the fluxes of the following vector fields:
   (a) \( \mathbf{F} = xyz\mathbf{i} + x\mathbf{j} - y\mathbf{k} \) through the square of side 2 centered on the \( x \)-axis in plane \( x = 3 \) and oriented in the negative \( x \)-direction;
   (b) \( \mathbf{F} = -2\mathbf{r} \) through the sphere of radius 5 centered at the origin and oriented outward;
   (c) \( \mathbf{F} = yi - xj + k \) through the upper hemisphere of radius 2 centered at the origin and oriented upward;
   (d) \( \mathbf{F} = yi - xj + zk \) through the sphere of radius 2 centered at the origin and oriented outward;
   (e) \( \mathbf{F} = yi + xj + zk \) through the entire surface (oriented inward) of the solid cylinder defined by the inequalities \( x^2 + y^2 \leq 4 \) and \( 0 \leq z \leq 3 \);
   (f) \( \mathbf{F} = xj + xyk \) through the entire surface (oriented outward) of the solid region defined by the inequalities \( 0 \leq z \leq 1 - x^2 - y^2 \);
   (g) \( \mathbf{F} = xj + xyk \) through the part of the plane \( x + 2y + 3z = 6 \) (oriented upward) over the region in the \( xy \)-plane defined by the inequalities \( x \geq 0, y \geq 0, x + 2y \leq 6 \).

5. Identify each of the 7 parts in Problem 4 which deals with the flux through a closed surface (that is, through the entire surface of a solid region.) In each such case, use the Divergence Theorem to verify the result you obtained in Problem 4.