1. Use a transformation to evaluate $\int_0^1 x^2 y^3 \, dx \, dy$, where $R$ is the rectangle enclosed by the lines $x = 2e + 1$, $y = 2e + 1$, $x = 1 - 3e$ and $y = 1 - 3e$.

2. Find the surface area of the portion of the surface $z = 4y + 3z$ that lies between $y = 2z$, $y = 0$ and $x = 2$.

3. Evaluate the double integral $\int_{x=0}^{x=2} \int_{y=0}^{y=3} f(x,y) \, dy \, dx$, by interchanging the order of integration.

4. Let $D$ be the solid enclosed by $x = y + 2$, $x^2 + 3z = 9$ and $y = 0$.

(a) Sketch the solid region $D$.

(b) Set-up (do not solve) the triple integral in Cartesian coordinates necessary to find the volume of the region $D$.

5. Using spherical coordinates, find the volume of the solid region $E$ bounded by the sphere $x^2 + y^2 + z^2 = 6$ and the planes $x = 0$ and $z = 1$.

6. Using cylindrical coordinates, evaluate $\iiint_E \rho \, dV$, where $E$ is the region enclosed between $z = x^2 + y^2$ and $x = 0$ and inside $x^2 + y^2 = 4$.

7. Find the volume of the tetrahedron bounded by the coordinate planes and the plane with points (3,2,0), (2,0,2) and (0,0,3).

8. Set-up and evaluate using Green's Theorem a line integral for the Total Work done in moving a point through the force field $\mathbf{F} = -x \mathbf{i} + y \mathbf{j}$ around the angular region bounded by the $x$-axis, $x = 1$ and the line $y = 2x$, in a counter-clockwise fashion.
9. Use a suitable potential function to evaluate the line integral
\[ \int (2x+y+1)dx + (x^2 + 4y + 2)dy \] where \( C \) is any curve connecting (-1,2) to (0,1).

\[ f_x = 3x, \quad f_y = x + y + 2 \]
\[ f(x) - f(1,0) = 3x - 3 \]
\[ \int (2x+y+1)dx + (x^2 + 4y + 2)dy = f(x) - f(1,0) = 3x - 3 \]

11. Given \( f(x,y) \) is a differentiable function with \( x = \cos \theta \) and \( y = \sin \theta \), show that \( f_x = -f_y \sin \theta + f_y \cos \theta \).

12. For the space curve \( r(t) = \langle t, e^{-t}, \sqrt{2}t \rangle \), calculate the arclength for \( 0 \leq t \leq 1 \).

\[ \begin{align*}
& \int_0^1 \sqrt{t^2 + e^{-2t} + 2t^2} \, dt = \int_0^1 \sqrt{t^2 + e^{-2t} + 2t^2} \, dt \\
& = \int_0^1 \sqrt{t^2 + e^{-2t} + 2t^2} \, dt \\
& = \int_0^1 \sqrt{t^2 + e^{-2t} + 2t^2} \, dt.
\end{align*} \]