1. Use polar coordinates to find $\iint_D e^{-x^2-y^2} \, dA$, where $D$ is the region bounded by the semicircle $x = \sqrt{4-y^2}$ and the $y$-axis. (5pt)

2. Find the average value of $f(x, y) = 3xy$ over region $D$, where $D$ is the triangle with vertices $(0, 0), (1, 0)$ and $(1, 9)$. (5pt)
3. Find the volume of the solid that lies under the plane $3x + 2y + z = 12$ and above the rectangle $R = \{(x, y) | 0 \leq x \leq 1, -2 \leq y \leq 4\}$. (5pt)

4. Find the dimensions of the box with volume 1000 $cm^3$ that has minimal surface area. (Let $x, y, z$ be the dimensions of the box). (5pt)
5. Use Lagrange multipliers to find the maximum and minimum values of \( f(x, y, z, t) = x + y + z + t \), subject to \( x^2 + y^2 + z^2 + t^2 = 1 \). (5pt)

6. Given curve \( r(t) = (9t, 3\cos t, 3\sin t) \), \(-5 \leq t \leq 5\), find

   (i) its length. (5pt)

   (ii) its curvature. (5pt)
7. Find the work done by the force field $F(x, y) = (x, y)$ on a particle that moves along the parabola $y = x^2$ from $(-1, 1)$ to $(2, 4)$. (5pt)

8. Find the work done by the force field $F = (e^{-y}, -xe^{-y})$ in moving an object from $(0, 1)$ to $(2, 0)$. (5pt)