1. Find all critical points of
\[ f(x, y) = \frac{1}{3}x^3 + \frac{1}{3}y^3 - 2xy \]
and classify them as local maximum, local minimum, or saddle points.

2. Sketch the region of integration and change the order of integration:
\[
\int_D f(x, y) \, dA = \int_0^1 \int_0^{\sqrt{x^2}} f(x, y) \, dy \, dx + \int_1^2 \int_0^{1 - \sqrt{1 - (x - 2)^2}} f(x, y) \, dy \, dx
\]

3. For the function \( f(x, y) = xy^2 + x^3 - 2xy \) the point \((x, y) = \left(\frac{1}{\sqrt{3}}, 1\right)\) is
   a. a local minimum
   b. a local maximum
   c. a saddle point
   d. not a critical point
   e. is a critical point but the Second Derivative Test fails.

4. Let \( f(x, y) = xy - 2x + 5 \).
   Find the absolute maximum and minimum values of \( f \) on the set \( D \) which is the closed triangular region with vertices \( A(0, 0), B(1, 1), C(0, 1) \).

5. For
\[
\int_0^3 \int_{y^2}^9 f(x, y) \, dx \, dy
\]
   (a) sketch the region of integration;
   (b) change the order of integration.

6. Find the volume of the solid that lies under the paraboloid \( z = x^2 + y^2 \), above the \( xy \)-plane, and inside the cylinder \( x^2 + y^2 = 4 \).

7. Let \( C \) be the line segment starting at \((0, 1, 1)\) and ending at \((3, 1, 4)\).
   a) Find parametric equations for \( C \).
   b) Find the mass of a thin wire in the shape of \( C \) with the density \( \rho(x, y) = x + y \).

8. A particle moves along the curve \( C : \vec{r}(t) = \langle t^3, t^2, t \rangle \) from the point \((1, 1, 1)\) to the point \((8, 4, 2)\) due to the force \( \vec{F}(x, y, z) = \langle z, y, x \rangle \). Find the work done by the force.
9. Find the absolute maximum and minimum values of \( f(x, y) = x^2y + xy^2 + y^2 - y \) on the set \( D \) which is the closed rectangular region in the \( xy \)-plane with vertices \((0, 0), (0, 2), (2, 0)\) and \((2, 2)\).

10. Evaluate the integral by reversing the order of integration:

\[
\int_0^3 \int_{y^2}^9 y \cos(x^2) \, dx \, dy.
\]

11. Find the mass of the lamina that occupies the region bounded by the parabola \( x = y^2 \) and the line \( y = x - 2 \) and has the density \( \rho(x, y) = 3 \).

12. Find the volume of the solid that lies under the paraboloid \( z = 4 - x^2 - y^2 \) and above the \( xy \)-plane.

13. Find the line integral of the vector field \( \mathbf{F}(x, y, z) = (-yz^2, xz^2, z^3) \) around the circle \( \mathbf{r}(t) = (2 \cos t, 2 \sin t, 8) \).

14. Find the mass of the quarter circle \( x^2 + y^2 \leq 9 \) for \( x \geq 0 \) and \( y \geq 0 \) if the density is \( \rho(x, y) = \sqrt{x^2 + y^2} \).

15. Find the center of mass of the quarter circle \( x^2 + y^2 \leq 9 \) for \( x \geq 0 \) and \( y \geq 0 \) if the density is \( \rho(x, y) = \sqrt{x^2 + y^2} \).

16. Let

\[
f(x, y) = 4xy^2 - x^2y^2 - xy^3.
\]

Find the absolute maximum and minimum values of \( f \) on the set \( D \) which is the closed triangular region with vertices \( A(0, 0), B(0, 6), C(6, 0) \).

17. Let

\[
f(x, y) = e^{-x^2-y^2}(x^2 + 2y^2).
\]

Find the absolute maximum and minimum values of \( f \) on the set \( D \) which is the disk \( x^2 + y^2 \leq 4 \).

18. Calculate the value of the integral \( \int \int_D (x^2 + y^2)^{3/2} \, dA \), where \( D \) is the region in the first quadrant bounded by the lines \( y = 0 \), \( y = \sqrt{3}x \) and the circle \( x^2 + y^2 = 9 \).