1. (3 points) **Surfaces & Level Sets:** Investigate the shape of the surface $S$ given by the following parametric equation

\[ x = \sqrt{\nu} \cos u, \quad y = \sqrt{\nu} \sin u, \quad z = 2\nu \]

(a) Write the equation of $S$ in standard form, i.e. find the function of two variables $z = f(x, y)$, such that $S$ is the graph of this function.

(b) Find three level curves of $z = f(x, y)$, i.e. the curve with equation $f(x, y) = k$, where $k$ is a constant. Can you figure out what all the level curves look like?

(c) Is the surface $S$ a surface of revolution? Try to illustrate your conclusion.
2. Suppose that $f(x, y) = \frac{x^2 y}{x^4 + y^2}$.

(a) (1 point) Show that $f(x, y) \to 0$ as $(x, y) \to (0, 0)$ along any line $y = mx$.

(b) (1 point) Show that $f(x, y) \to \frac{1}{2}$ as $(x, y) \to (0, 0)$ along the parabola $y = x^2$.

(c) (1 point) What conclusions can you draw? Explain.
3. Find the Limits Using Known Limits

(a) (1 point) \( \lim_{(x,y) \to (0,0)} (1 + \frac{3x^2y}{x^2 + y^2})^{\frac{x^2+y^2}{3x^2y}} \).

(b) (1 point) \( \lim_{(x,y) \to (0,0)} \frac{\sin[(y + 1)\sqrt{x^2 + y^2}]}{\sqrt{x^2 + y^2}} \).
4. Polar Coordinates and Continuity

(a) (1 point) Suppose that \( f(x, y) = \frac{x^2 - y^2}{x^2 + y^2} \), use polar coordinates to verify that \( f \) is not continuous at the origin.

(b) (1 point) Use the following plot of several contours of \( f \) to argue that \( f \) is not continuous at the origin.