1. The **dimension** of an object is the minimum number of coordinates needed to specify every point within it. For the following objects, give the dimension of each.

2. Consider the parametrization \( \Phi(s, t) = (a \cos s \sin t, a \sin s \sin t, a \cos t), 0 \leq s \leq 2\pi, 0 \leq t \leq \pi \) and \( a \) is a fixed positive constant.

   (a) Identify this surface by finding a Cartesian equation \( F(x, y, z) = c \). (Hint: What change of variables transformation does this look like?)

   (b) Give a geometric interpretation of the parameters \( s \) and \( t \).

3. Find a parametrization of each surface in \( \mathbb{R}^3 \).

   (a) The part of the upper hemisphere \( x^2 + y^2 + z^2 = a^2, z \geq 0 \), cut out by the cone \( z^2 = x^2 + y^2 \).
(b) The part of the plane \( z - 3y + x = 2 \) inside the cylinder \( x^2 + y^2 = 4 \).
(c) The part of the cone \( x^2 + y^2 = z^2 \) between the planes \( z = 1 \) and \( z = 4 \).

4. Find an equation of the tangent plane to the parametric surface given by \( \mathbf{r}(u, v) = u^2 \mathbf{i} + 2u \sin v \mathbf{j} + u \cos v \mathbf{k} \) at the point \( u = 1, \ v = 0 \).

5. Is the surface \( z = x^2 - y^2 \) smooth?

6. Find the area of the helicoid (spiral ramp) with vector equation \( \mathbf{r}(u, v) = u \cos v \mathbf{i} + u \sin v \mathbf{j} + v \mathbf{k} \) where \( 0 \leq u \leq 1 \) and \( 0 \leq v \leq \pi \).

7. Find the area of the surface \( z = 1 + 3x + 2y^2 \) the lies above the triangle with vertices \((0, 0)\), \((0, 1)\) and \((2, 1)\).

8. The figure shows the surface created when the cylinder \( y^2 + z^2 = 1 \) intersects the cylinder \( x^2 + z^2 = 1 \). Find the area of this surface.

9. Find a parametric representation of the torus obtained by rotating about the \( z \)-axis the circle in the \( xz \)-plane with center \((0, 0, b)\) and radius \( 0 < a < b \) using the angles \( \theta \) and \( \alpha \) shown in the figure. Use your parametric representation to find the surface area of the torus.