1. (20 pts) We consider here the points \( \vec{a} = (1, 0, 0), \vec{b} = (0, 1, 0), \vec{c} = (0, 0, 1), \vec{k} = (3, 3, 6). \) (A) Find the magnitude of the vector \( \vec{d} \) represented by the arrow with tail at \( \vec{a} \) and head at \( \vec{k} \). (B) Find a vector \( \vec{p} \) perpendicular to the plane \( P \) containing \( \vec{a}, \vec{b}, \vec{c} \). (C) Find the equation of the plane \( Q \) that is parallel to \( P \) and contains \( \vec{k} \). (D) Find \( \vec{d} \cdot \vec{p} \) as part of a computation of the distance from \( \vec{k} \) to \( P \).

2. (20 pts) (A) Identify a standard curve of high school algebra and an explicit, ordered sequence of geometric transformations on it by which you can produce the surface \( S \) with equation \( 4x^2 + z^2 = e^{2y-3} \). (B) Cross sections of \( S \) parallel to one of the coordinate planes give ellipses; identify which coordinate plane this is.

3. (20 pts) (A) The surface \( S \) has equation \( xe^{y} + y^2z = z^3 \). Find functions \( f \), \( g \), and \( h \), along with their domains and targets, for which \( S \) is the graph, a level set, and an image (respectively). (B) Parametrize the curve that is the intersection of \( S \) with the cylinder \( y^2 + z^2 = 9 \).

4. (20 pts) \( T \) is a linear transformation from \( \mathbb{R}^3 \) to \( \mathbb{R}^3 \), and we know \( T(1, 4, 2) = (3, 2, 5), T(0, 1, 2) = (1, 0, 1), T(0, 0, 1) = (1, 1, 1) \). (A) Find the matrix representing \( T \). (B) Find the matrix representing \( T \circ S \), where \( S \) reflects vectors through the plane \( x = y \).

5. (20 pts) Compute directly from the definition the directional derivative \( D_{\vec{v}}g(\vec{a}) \), where \( \vec{a} = \vec{0}, \vec{v} = (2, 3), \) and \( g : \mathbb{R}^2 \to \mathbb{R}^2 \) is defined by \( g(x, y) = (xe^y, y \sin x) \).