1. Given a parametrized curve
\[ \alpha(s) = (\cos s/2, \sin s/2, s\sqrt{3}/2) \]
Show that the parameter \( s \) is the arclength. Determine the curvature \( k(s) \), the torsion \( \tau(s) \) and the Frenet trihedron \( t(s), n(s), b(s) \).

2. Let \( \alpha : I \subset \mathbb{R} \to \mathbb{R}^3 \) be a regular curve parametrized by arclength \( s \). Assume that the curvature \( k(s) \) is never zero but the torsion \( \tau(s) \) is identically zero. Show that the trace of \( \alpha \) must be contained in a plane.

3. Show that the cylinder \( \{(x, y, z) \in \mathbb{R}^3; x^2 + y^2 = 1\} \) is a regular surface, and find parametrizations whose coordinate neighborhoods cover it. Compute the tangent space to the cylinder at \((x, y, z) = (1, 0, 0)\).

4. Let \( S_1 = \{(x, y, z) \in \mathbb{R}^3; -1 < x < 1, z = 0\} \) be the \( xy \)-plane and let \( S_2 = \{(x, y, z) \in \mathbb{R}^3; z = -\sqrt{1-x^2}, -1 < x < 1\} \) be the half cylinder. Let \( \varphi : S_1 \to S_2 \) be the map sending \((x, y, 0) \in S_1 \) to \((x, y, -\sqrt{1-x^2}) \in S_2\). Let \( p \) be the point \((1/2, 0, 0) \in S_1 \) and \( w \) be the tangent vector \((2, 3, 0) \in T_p(S_1) \). Let \( d\varphi_p : T_p(S_1) \to T_{\varphi(p)}(S_2) \) be the differential. Compute \( d\varphi_p(w) \).