(1) Find a basis for the tangent space to the ellipse \( x^2 + y^2 + 4z^2 = 16 \) at the points \((4, 0, 0)\) and \((2, 2, \sqrt{2})\). Recall each of these tangent spaces is a 2-dimensional subspace of \(\mathbb{R}^3\).

(2) In a previous homework you showed that \(\text{SL}(2, \mathbb{R})\) is a 3-dimensional manifold in \(\mathbb{R}^4\) (having identified \(\mathbb{R}^4\) with the vector space of \(2 \times 2\) matrices). What is the tangent space to this manifold at the identity matrix?

(3) Calculate the integral of the covector field \(\omega = x\,dy + y\,dz\) over the smooth curve \(c(t) = (\sin t, \cos t, t) = (x, y, z)\) in \(\mathbb{R}^3\):
\[
\int_c x\,dy + y\,dz =
\]

(4) Compute the integral of the covector field \(\sigma = ydx - xdy + zdz\) over the circle in \(\mathbb{R}^3\) with center \((0, 0, 2)\) and radius 3, and which lies in the plane \(z = 2\). Parametrize the circle clockwise as viewed from above. Is it possible that \(\omega = df\) for some smooth function \(f\) on \(\mathbb{R}^3\)? Explain.