1. An ant moves along a helical path

\[ \mathbf{r}(t) = \begin{pmatrix} 2 \cos t \\ 2 \sin t \\ 3t \end{pmatrix}. \]

(a) At what rate is her distance from the origin changing when \( t = 0 \)? When \( t = 2\pi \)?

(b) If the temperature is given by \( T(x, y, z) = xy + z + z^2 \), at what rate is the temperature changing for the ant when \( t = \pi/4 \)?

2. Let \( U \) be open in \( \mathbb{R}^n \), and \( f: U \to \mathbb{R} \) be differentiable. Let \( a \in U \), and assume \( f(a) \neq 0 \). Prove that \( 1/f \) is differentiable at \( a \), and find a formula for its derivative.

3. Find the equation of the tangent plane to the surface \( x^2 + y^2 + z^2 = 14 \) at the point \((1, 2, 3)\).

4. Let

\[ f(x, y) = xy \frac{x^2 - y^2}{x^2 + y^2}, \quad (x, y) \neq 0 \]

and \( f(0, 0) = 0 \). Calculate its second order partial derivatives everywhere. Is the function \( C^2 \)?

5. Suppose \( f: \mathbb{R}^2 \to \mathbb{R} \) is a differentiable function whose gradient is never 0 and satisfies

\[ \frac{\partial f}{\partial x} = 2 \frac{\partial f}{\partial y} \]

everywhere. Find the level curves of \( f \).