1. A rain falling on a mountainside at the point \((1, 1)\) will flow in the direction of fastest decrease in elevation. The height of the mountain near \((1, 1)\) is given by \(f(x, y) = 5 - x^2 + 2y^2\).

(a) What is the unit vector \(u\) that describes the direction of the raindrop’s motion?

(b) What is the directional derivative in this direction?

2. Let \(f(x, y, z)\) be a function of three variable which satisfies

\[
\begin{align*}
f_x(4, 1, 2) &= 3, \\ f_y(4, 1, 2) &= 7, \\ f_z(4, 1, 2) &= 5.
\end{align*}
\]

Let \(x(s, t) = s + 2t, y(s, t) = t^2,\) and \(z(s, t) = st\). Find \(\frac{\partial f}{\partial t}\) at the point \((s, t) = (2, 1)\).
3. Let \( f(x, y) = x \sin(xy) \). (a) Find the tangent plane at the point \((1, \pi)\). Write the plane in the form \( z = Ax + By + C \).

(b) A calculator will tell you that \( .9 \sin(.9\pi) \approx .28712 \approx .08853\pi \). Estimate this value with a linear approximation, using the work you did in part (a).