1. The picture shows the contour map for a hill 70 feet high, which we assume has the equation \( z = f(x, y) \).

   (a) A raindrop landing on the hill at point \( A \) will reach the \( xy \)-plane at \( A' \), by following the path of steepest descent from \( A \). Draw the path from \( A \) to \( A' \).

   (b) What are the coordinates of the point \( A' \)?

   (c) Estimate \( f_x \) at the point \( B \).

   (d) Estimate \( f_y \) at the point \( B \).

   (e) Estimate \( D_\vec{u} f \) at the point \( C \), where \( \vec{u} = \frac{i + j}{\sqrt{2}} \).

2. Let \( f(x, y) = x \ln(x^2 + y^2) \). Find \( \nabla f(1, 2) \).

3. Find the directional derivative of \( f(x, y) = y^2 \ln x \) at the point \( (1, 2) \) in the direction of \( \vec{a} = \frac{i}{3} - \frac{j}{3} \).

4. Find the equation of the plane tangent to the surface \( z = x^3 y + 3xy^2 \) at the point where \( x = 2 \) and \( y = -2 \).