Each problem is worth 5 points. Clear and complete justification is required for full credit.

1. Find the gradient of the function \( f(x, y) = \ln(x^2 + y^4) \) at the point (2,1).
   
   \[
   f(x, y) = \ln(x^2 + y^4) \\
   f_x(x, y) = \frac{2x}{x^2 + y^4} \\
   f_y(x, y) = \frac{4y^3}{x^2 + y^4} \\
   f_x(2, 1) = \frac{2(2)}{(2^2 + 1^4)} = \frac{4}{5} \\
   f_y(2, 1) = \frac{4(1^3)}{(2^2 + 1^4)} = \frac{4}{5}
   \]
   
   \[\text{grad} \ f(2, 1) = \left\langle \frac{4}{5}, \frac{4}{5} \right\rangle\]
   
2. Find the directional derivative of the function \( g(x, y) = x^2y - y^3 \) in the direction of the vector \( \langle 3, -4 \rangle \) at the point (1,2).
   
   \[
   \mathbf{u} = \frac{\langle 3, -4 \rangle}{\sqrt{3^2 + (-4)^2}} = \frac{\langle 3, -4 \rangle}{\sqrt{25}} = \langle \frac{3}{5}, -\frac{4}{5} \rangle
   \]
   
   \[
   g_x(x, y) = 2xy \\
   g_y(x, y) = x^2 - 3y^2 \\
   g_x(1, 2) = 4 \\
   g_y(1, 2) = -11
   \]
   
   \[D = \frac{3}{5} \cdot 4 + \left(-\frac{4}{5}\right)(-11)\]
   
   \[= \frac{12}{5} + \frac{44}{5} = \frac{56}{5}\]