1. Let \( f(s,t) = (s^2t^2, s^3 + t^3) \) and \( g(x,y) = (e^{xy}, \cos(x+y)) \) and let \( u = g \circ f \).

1A) Find the entries of the two Jacobian matrices \( J_g \) and \( J_f \). Leave the entries in \( J_g \) in terms of \( x \) and \( y \) and those for \( J_f \) in terms of \( s \) and \( t \).

\[
J_g = \begin{bmatrix}
y^2e^{xy} & 2xye^{xy} \\
-sin(xy) & -sin(xy)
\end{bmatrix};

J_f = \begin{bmatrix}
4s^3t^2 & 2s^4t \\
3s^2 & 3t^2
\end{bmatrix}
\]

1B) Use the answer to 1A to actually find \( \partial u_1/\partial s \) in terms of \( s \) and \( t \).

\[
\begin{align*}
\text{(It's the first row of } J_g \circ J_f, \text{ which is...)} \\
(y^2e^{xy})(4s^3t^2) + (2xye^{xy})(3s^2) &= \\
(s^3 + t^2)^2 e^{x^2 + 3^2} + 2(s^4t^2)(s^3 + t^3) e^{s^2 + t^2} &
\end{align*}
\]

2. The level curves of some function \( f(x,y) \) are shown below.

2A) Use the level curves to make good estimates of \( \partial f/\partial x \) and \( \partial f/\partial y \) at the point \((1,1)\). The vertical and horizontal thick lines there have lengths of about 0.3 and 0.13, respectively. Show your computations and label your answers.

\[
\begin{align*}
\frac{\partial f}{\partial x} \bigg|_{(1,1)} &\approx \frac{0.25}{0.13} \approx 1.923 \\
\frac{\partial f}{\partial y} \bigg|_{(1,1)} &\approx \frac{0.25}{0.13} \approx 0.833
\end{align*}
\]

2B) What is the partial \( \partial f/\partial x \) at the point \( p \) shown? Explain!

It's 0 because at \( p \) the level curve is "pointing" in the direction of no change, and is pointing \( \perp \) to the \( x \)-axis, thus no (instantaneous) rate of change in \( f \) up to \( x \) at \( p \).