1. *We will use two different notations when taking partial derivatives. Match each expression in the first column to its corresponding expression in the second column.

\[
\begin{array}{ll}
\frac{\partial^2 f}{\partial x^2} & f_x \\
\frac{\partial^2 f}{\partial y \partial x} & f_{xy} \\
\frac{\partial f}{\partial x} & f_x \\
\frac{\partial^2 f}{\partial x \partial y} & f_{yx}
\end{array}
\]

2. *Let \( f(x, y) = \cos(x^2 + 3y) \). Compute the following quantities:

(a) \( \frac{\partial f}{\partial x} \)
(b) \( \frac{\partial f}{\partial y} \)
(c) \( \frac{\partial^2 f}{\partial x \partial y} \)
(d) \( \frac{\partial^2 f}{\partial y \partial x} \)
(e) \( \frac{\partial^2 f}{\partial x^2} \)

3. *Shown below are some level curves for the function \( f : \mathbb{R}^2 \rightarrow \mathbb{R} \). Complete the following statements, and determine whether the various partial derivatives are positive, negative, or 0.
(a) \( f_x = \frac{\partial}{\partial x} f \) is the rate of change of \( f \) as \( x \) varies. To find \( f_x \) at any point, we fix the variable \( y \) at this point, allow the variable \( x \) to vary around this point, and look at how the value of the function changes as \( x \) increases. If as \( x \) increases the value of the function increases, then \( f_x \) is _______; and if as \( x \) increases the value of the function decreases, then \( f_x \) is _______.
The value of \( f_x(a) \) is _______.

(b) \( f_{yy} = \frac{\partial}{\partial y} f_y \) is the rate of change of _____ as _____ varies. To find \( f_{yy} \) at any point, we fix the variable _____ at this point, allow the variable _____ to vary around this point, and look at how the value of _____ changes as _____ increases. If as \( y \) increases the value of \( f_y \) increases, then \( f_{yy} \) is _______; and if as \( y \) increases the value of \( f_y \) decreases, then \( f_{yy} \) is _______.
\( f_{yy}(c) \) is _______.

(c) \( f_{xx} = \frac{\partial}{\partial x} f_x \) is the rate of change of _____ as _____ varies. To find \( f_{xx} \) at any point, we fix the variable _____ at this point, allow the variable _____ to vary around this point, and look at how the value of _____ changes as _____ increases. If as \( x \) increases the value of \( f_x \) increases, then \( f_{xx} \) is _______; and if as \( x \) increases the value of \( f_x \) decreases, then \( f_{xx} \) is _______.
\( f_{xx}(d) \) is _______.

(d) \( f_{xy} = \frac{\partial}{\partial y} f_x \) is the rate of change of _____ as _____ varies. To find \( f_{xy} \) at any point, we fix the variable _____ at this point, allow the variable _____ to vary around this point, and look at how the value of _____ changes as _____ increases. If as \( y \) increases the value of \( f_x \) increases, then \( f_{xy} \) is _______; and if as \( y \) increases the value of \( f_x \) decreases, then \( f_{xy} \) is _______.
\( f_{xy}(b) \) is _______.

(e) Find and label a point \( e \) on the graph where \( f_x = 0 \) but where \( f_y < 0 \).

(f) Find and label a point \( g \) on the graph where \( f_y = 0 \) but where \( f_x > 0 \).

(g) Mark all of the points where the tangent plane to the graph of the function \( g \) is horizontal. At each of these points, what is the value of both \( f_x \) and \( f_y \)?