Math 2433
12021 - SR 117 - MWF 12-1

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A collection of level curves can give a good representation of the 3-d graph.

**Example 1:** Identify the level curves for $c = \{-2, -1, 0, 1, 2\}$ and sketch the curves corresponding to the indicated values of $c$ for $f(x, y) = x^2 - y^2$
Example 2: Identify the $c$-level surface at $c = 0$

\[ f(x, y, z) = 4x^2 - 9y^2 - 72z. \]

Solution:
1. Identify the level curve of \( f(x, y) = \frac{x^2}{x - y^2} \)

a. parabolas
b. hyperbolas
c. ellipses
d. exponentials
e. circles
14.4 Partial Derivatives

For functions of two variables:

The partial derivative of $f$ with respect to $x$ is the function $f_x$ obtained by differentiating $f$ with respect to $x$, treating $y$ as a constant.

The partial derivative of $f$ with respect to $y$ is the function $f_y$ obtained by differentiating $f$ with respect to $y$, treating $x$ as a constant.
14.4 Partial Derivatives

For functions of three variables:

The partial derivative of $f$ with respect to $x$ is the function $f_x$ obtained by differentiating $f$ with respect to $x$, treating $y$ and $z$ as constants.

The partial derivative of $f$ with respect to $y$ is the function $f_y$ obtained by differentiating $f$ with respect to $y$, treating $x$ and $z$ as constants.

The partial derivative of $f$ with respect to $z$ is the function $f_z$ obtained by differentiating $f$ with respect to $z$, treating $x$ and $y$ as constants.
Example 1: Find all first partial derivatives of \( f(x, y) = 3x^2 - 2y + xy \).

Solution:
14.4 Partial Derivatives

Example 2: Find all first partial derivatives of
\[ f(x, y) = e^{x+y^2} + \ln \left( \frac{x}{x^2 + y} \right). \]

Solution:
Example 3: Find all first partial derivatives of
\[ f(x, y, z) = 3x^2 z - e^y \sqrt{z} + \sqrt{x^2 + y^2}. \]
Solution:
Given \( f(x, y) = e^{\sin(x)} + x^5 y + \ln(1 + y^2) \)

2. Find \( f_x \)

3. Find \( f_y \)

(answer choices for both)
In the cases of higher order derivatives:

\[(f_x)_x = f_{xx} = \frac{\partial}{\partial x} \left( \frac{\partial f}{\partial x} \right) = \frac{\partial^2 f}{\partial x^2}\]

\[(f_x)_y = f_{xy} = \frac{\partial}{\partial y} \left( \frac{\partial f}{\partial x} \right) = \frac{\partial^2 f}{\partial y \partial x}\]

\[(f_y)_x = f_{yx} = \frac{\partial}{\partial x} \left( \frac{\partial f}{\partial y} \right) = \frac{\partial^2 f}{\partial x \partial y}\]

\[(f_y)_y = f_{yy} = \frac{\partial}{\partial y} \left( \frac{\partial f}{\partial y} \right) = \frac{\partial^2 f}{\partial y^2}\]
Example 1: Find all first and second partial derivatives of 
\( f(x, y) = 2x^2 \cos(y) + 3y^2 \sin(x) \).

Solution: