

## 14 □ PARTIAL DERIVATIVES

### 14.1 Functions of Several Variables

1. (a)  $f(x, y) = \frac{x^2 y}{2x - y^2} \Rightarrow f(1, 3) = \frac{1^2(3)}{2(1) - 3^2} = -\frac{3}{7}$

(b)  $f(-2, -1) = \frac{(-2)^2(-1)}{2(-2) - (-1)^2} = \frac{4}{5}$

(c)  $f(x + h, y) = \frac{(x + h)^2 y}{2(x + h) - y^2}$

(d)  $f(x, x) = \frac{x^2 x}{2x - x^2} = \frac{x^3}{x(2 - x)} = \frac{x^2}{2 - x}$

2. (a)  $g(x, y) = x \sin y + y \sin x \Rightarrow g(x, 0) = x \sin 0 + 0 \sin x = x \cdot 0 + 0 - 0 = 0$

(b)  $g\left(\frac{\pi}{2}, \frac{\pi}{4}\right) = \frac{\pi}{2} \sin \frac{\pi}{4} + \frac{\pi}{4} \sin \frac{\pi}{2} = \frac{\pi}{2} \left(\frac{\sqrt{2}}{2}\right) + \frac{\pi}{4}(1) = \frac{\pi(\sqrt{2} + 1)}{4}$

(c)  $g(0, y) = 0 \sin y + y \sin 0 = 0 + y \cdot 0 = 0$

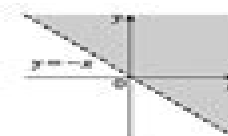
(d)  $g(x, y + h) = x \sin(y + h) + (y + h) \sin x$

3. (a)  $g(x, y) = x^2 \ln(x + y) \Rightarrow g(3, 1) = 3^2 \ln(3 + 1) = 9 \ln 4$

(b)  $\ln(x + y)$  is defined only when  $x + y > 0 \Rightarrow y > -x$ .

Thus, the domain of  $g$  is  $\{(x, y) \mid y > -x\}$ .

(c) The range of  $\ln(x + y)$  is  $\mathbb{R}$ , so the range of  $g$  is  $\mathbb{R}$ .

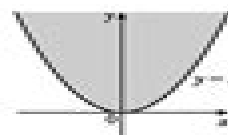


4. (a)  $h(x, y) = e^{\sqrt{y-x^2}} \Rightarrow h(-2, 5) = e^{\sqrt{5-(-2)^2}} = e^{\sqrt{1}} = e$

(b)  $\sqrt{y-x^2}$  is defined only when  $y-x^2 \geq 0 \Rightarrow y \geq x^2$ .

Thus, the domain of  $h$  is  $\{(x, y) \mid y \geq x^2\}$ .

(c) We know  $\sqrt{y-x^2} \geq 0 \Rightarrow e^{\sqrt{y-x^2}} \geq 1$ . Thus, the range of  $h$  is  $[1, \infty)$ .



5. (a)  $F(x, y, z) = \sqrt{y} - \sqrt{x-2z} \Rightarrow F(3, 4, 1) = \sqrt{4} - \sqrt{3-2(1)} = 2 - 1 = 1$

(b)  $\sqrt{y}$  is defined only when  $y \geq 0$ .  $\sqrt{x-2z}$  is defined only when  $x-2z \geq 0 \Rightarrow x \leq \frac{1}{2}x$ . Thus, the domain is  $\{(x, y, z) \mid x \geq 2z, y \geq 0\}$ , which is the set of points on or below the plane  $x = \frac{1}{2}x$  and on or to the right of the  $xz$ -plane.

6. (a)  $f(x, y, z) = \ln(x - \sqrt{x^2 + y^2}) \Rightarrow f(4, -3, 6) = \ln(4 - \sqrt{4^2 + (-3)^2}) = \ln(4 - \sqrt{25}) = \ln 1 = 0$

(b)  $\ln(x - \sqrt{x^2 + y^2})$  is defined only when  $x - \sqrt{x^2 + y^2} > 0 \Rightarrow x > \sqrt{x^2 + y^2} \Rightarrow x^2 > x^2 + y^2$ . Thus, the domain is  $\{(x, y, z) \mid x > \sqrt{x^2 + y^2}\}$ , which is the set of points inside the top half of the cone  $x^2 = x^2 + y^2$ .

# Calculus Solution

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