

14 □ PARTIAL DERIVATIVES

14.1 Functions of Several Variables

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

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

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

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

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

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

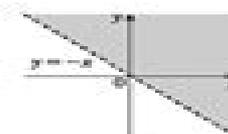
(d) $g(x, y + h) = x \sin(y + h) + (y + h) \sin x$

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} .

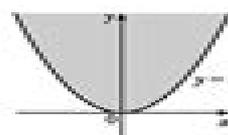


4. (a) $h(x, y) = e^{\sqrt{y - x^2}} \Rightarrow h(-2, 5) = e^{\sqrt{5 - (-2)^2}} = e^{\sqrt{1}} = e$

(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 $x^2 = x^2 + y^2$.

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Table of Contents Calculus Solution

1. Understanding the eBook Calculus Solution
 - The Rise of Digital Reading Calculus Solution
 - Advantages of eBooks Over Traditional Books
2. Identifying Calculus Solution
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Calculus Solution
 - User-Friendly Interface
4. Exploring eBook Recommendations from Calculus Solution
 - Personalized Recommendations
 - Calculus Solution User Reviews and Ratings
 - Calculus Solution and Bestseller Lists
5. Accessing Calculus Solution Free and Paid eBooks
 - Calculus Solution Public Domain eBooks
 - Calculus Solution eBook Subscription Services
 - Calculus Solution Budget-Friendly Options
6. Navigating Calculus Solution eBook Formats
 - ePub, PDF, MOBI, and More
 - Calculus Solution Compatibility with Devices
 - Calculus Solution Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Calculus Solution
 - Highlighting and Note-Taking Calculus Solution
 - Interactive Elements Calculus Solution
8. Staying Engaged with Calculus Solution

- Joining Online Reading Communities
- Participating in Virtual Book Clubs
- Following Authors and Publishers Calculus Solution
- 9. Balancing eBooks and Physical Books Calculus Solution
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Calculus Solution
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Calculus Solution
 - Setting Reading Goals Calculus Solution
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Calculus Solution
 - Fact-Checking eBook Content of Calculus Solution
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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