

# Comprehensive Study Guide for Multivariable Calculus

This study guide consolidates key concepts, formulas, and theorems from multivariable calculus, spanning geometric interpretations with vectors, differentiation, integrals, and coordinate transformations. The material is organized according to three major exam areas, providing a structured and thorough reference for in-depth learning and exam preparation.

## Exam 1: Chapters 12–14

### Chapter 12: Vectors & Geometry

- **Distance in  $\mathbb{R}^3$ :** [  $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$  ]
- **Equation of a Sphere:** [  $(x - a)^2 + (y - b)^2 + (z - c)^2 = r^2$  ]
- **Vector from A to B:** [  $\mathbf{v} = \langle x_2 - x_1, y_2 - y_1, z_2 - z_1 \rangle$  ]
- **Magnitude of a Vector:** [  $|\mathbf{v}| = \sqrt{x^2 + y^2 + z^2}$  ]
- **Unit Vector:** [  $\hat{\mathbf{v}} = \frac{\mathbf{v}}{|\mathbf{v}|}$  ]
- **Dot Product:** [  $\mathbf{a} \cdot \mathbf{b} = a_1 b_1 + a_2 b_2 + a_3 b_3 = |\mathbf{a}| |\mathbf{b}| \cos \theta$  ]
- **Cross Product:** [  $\mathbf{a} \times \mathbf{b} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$  ]
- **Scalar Projection:** [  $\text{comp}_{\mathbf{a}} \mathbf{b} = \frac{\mathbf{a} \cdot \mathbf{b}}{|\mathbf{a}|}$  ]
- **Vector Projection:** [  $\text{proj}_{\mathbf{a}} \mathbf{b} = \left( \frac{\mathbf{a} \cdot \mathbf{b}}{|\mathbf{a}|^2} \right) \mathbf{a}$  ]

# Multivariable Calculus Study Guide

**SJ Ball**



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