Cascade Schemes for Calculus Exercises

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Introduction

This document collects cascade schemes for exercises, techniques, and fundamental concepts in calculus, organized by chapter. Each scheme follows a hierarchical and synthetic model to facilitate quick consultation and memorization.

1 Integrals

Sample Cascade Scheme: Computing a Definite Integral

Computing a Definite Integral

Key Question: How do you compute a definite integral?

- **Check if the integrand is continuous**
- **Find an antiderivative $F(x)$ of the integrand**
- **Apply the Fundamental Theorem of Calculus**
  - $F(b) - F(a)$
- **Consider special cases**
  - Improper integrals
  - Discontinuous functions
- **Verify the result**

2 Multivariate Differential Calculus

Sample Cascade Scheme: Analyzing a Function of Two Variables

Analyzing a Function $f(x$

Key Question: How do you analyze a function of two variables?

- **Domain of definition**
- **Continuity and differentiability**
- **Compute gradients**
- **Find critical points**
  - Solve $\nabla f = 0$
- **Classify critical points**
  - Hessian matrix
  - Maximum, minimum, saddle points
- **Constrained extrema (if present)**
  - Lagrange multipliers method

3 Differential Equations

Sample Cascade Scheme: Solving a First-Order Linear Differential Equation

First-Order Linear Differential Equation

Key Question: How do you solve $y' + p(x)y = q(x)$?

- **Find the integrating factor**
  - $\mu(x) = e^{\int p(x)dx}$
- **Multiply both sides by** $\mu(x)$
- **Rewrite the left side as the derivative of a product**
- **Integrate both sides**
- **Isolate the general solution**