Calculus Study Guide

Chapter 1: Introduction to Derivatives

A derivative represents the rate of change of a function with respect to a variable.
In calculus, the derivative of a function $f(x)$ is denoted as $f'(x)$ or df/dx.

Key Concepts:
- The derivative measures instantaneous rate of change
- Geometrically, it represents the slope of the tangent line
- Derivatives are fundamental to optimization problems

The Power Rule:
If $f(x) = x^n$, then $f'(x) = n * x^{(n-1)}$

Example:
$f(x) = x^3$
$f'(x) = 3x^2$

Chapter 2: Chain Rule

The chain rule is used to differentiate composite functions.
If $y = f(g(x))$, then $dy/dx = f'(g(x)) * g'(x)$

Steps:
1. Identify the outer function f and inner function g
2. Find the derivative of the outer function $f'(g(x))$
3. Find the derivative of the inner function $g'(x)$
4. Multiply the results

Example:
Let $y = (x^2 + 1)^3$
Outer function: $f(u) = u^3$, where $u = x^2 + 1$
Inner function: $g(x) = x^2 + 1$

$f'(u) = 3u^2$
$g'(x) = 2x$

$dy/dx = 3(x^2 + 1)^2 * 2x = 6x(x^2 + 1)^2$

Practice Problems

1. Find the derivative of $f(x) = 5x^{\cdot} - 3x^2 + 7$
   Solution: $f'(x) = 20x^3 - 6x$

2. Find the derivative of $g(x) = (2x + 1)^{\cdot}$
   Solution: Using chain rule, $g'(x) = 5(2x + 1)^{\cdot} * 2 = 10(2x + 1)^{\cdot}$

3. Find the derivative of $h(x) = x^2 * \sin(x)$
   Solution: Using product rule, $h'(x) = 2x*\sin(x) + x^2*\cos(x)$

Tips for Success:
- Practice regularly
- Understand the concepts, don't just memorize
- Draw graphs to visualize derivatives
- Check your work by taking derivatives of simple functions