Common Derivative Patterns

$\frac{d}{dx}x^n = n \cdot x^{n-1}$ $\quad$ $\frac{d}{dx}a^x = a^x \cdot \ln a$ $\quad$ $\frac{d}{dx}\ln x = \frac{1}{x}$

$\frac{d}{dx}\sin x = \cos x$ $\quad$ $\frac{d}{dx}\cos x = -\sin x$ $\quad$ $\frac{d}{dx}\tan x = \sec^2 x$

$\frac{d}{dx}\sec x = \sec x \cdot \tan x$ $\quad$ $\frac{d}{dx}\csc x = -\csc x \cdot \cot x$ $\quad$ $\frac{d}{dx}\cot x = -\csc^2 x$

$\frac{d}{dx}\sin^{-1} x = \frac{1}{\sqrt{1-x^2}}$ $\quad$ $\frac{d}{dx}\tan^{-1} x = \frac{1}{1+x^2}$

Differentiation Rules and Techniques

Constant Rule: $\frac{d}{dx}\left[c \cdot f(x)\right] = c \cdot \frac{d}{dx} f(x)$

Power Rule: $\frac{d}{dx}x^n = n \cdot x^{n-1}$

Product Rule: $\frac{d}{dx}\left[f(x) \cdot g(x)\right] = f'(x) \cdot g(x) + f(x) \cdot g'(x)$

Quotient Rule: $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{f'(x) \cdot g(x) - f(x) \cdot g'(x)}{\left[g(x)\right]^2}$

Chain Rule: $\frac{d}{dx} f(g(x)) = f'(g(x)) \cdot g'(x)$

Implicit Differentiation

Logarithmic Differentiation

Common Integral Patterns

$$\int x^n\,dx = \frac{x^{n+1}}{n+1} + C \qquad \int a^x\,dx = \frac{a^x}{\ln a} + C \qquad \int \frac{dx}{x} = \ln|x| + C$$

$$\int \ln x\,dx = x\cdot\ln x - x + C \qquad \int \sin x\,dx = -\cos x + C \qquad \int \cos x\,dx = \sin x + C$$

$$\int \tan x\,dx = \ln|\sec x| + C \qquad \int \sec x\,dx = \ln|\sec x + \tan x| + C \qquad \int \sec^2 x\,dx = \tan x + C$$

$$\int \frac{dx}{a^2 + x^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right) + C \qquad \int \frac{dx}{\sqrt{a^2 - x^2}} = \sin^{-1}\left(\frac{x}{a}\right) + C$$

Integration Rules and Techniques

Power Rule: $\int x^n\,dx = \frac{x^{n+1}}{n+1} + C$

Substitution Rule

Integration by Parts: $\int u\,dv = uv - \int v\,du$

Partial Fraction Decomposition / Long Division

Trigonometric Identities (for powers of sine and cosine)

Topics to Review for the AP Exam
(Topics with an asterisk are BC only)

Limits

- Evaluate analytically, graphically, and numerically
- Defining end behavior and vertical asymptotes
- l'Hospital's Rule, including all indeterminate forms*
- Squeeze Theorem

Terms and Definitions

- Continuity
- Differentiability
- Limit definition for *e*
- Absolute and conditional convergence*
- Polar conversions*

Derivative

- Formal definition of a numerical and function derivative
- Concept as an instantaneous rate of change
- Numerical derivative as the slope of a tangent line to a curve
- Analytic rules for computation
- Implicit differentiation
- Differentiation of inverse functions
- Logarithmic differentiation

Differential Applications

- Approximation by slope of secant line
- Rectilinear motion
- Linearization, including error analysis
- Differentials
- Mean Value Theorem
- Graph Behavior, including 1^{st} and 2^{nd} Derivative Tests
- Related rates
- Optimization
- Planar motion using vector functions*
- Slope of tangents to parametric and polar curves*
- Differential Equations (see separate category below)

Topics to Review for the AP Exam
(Topics with an asterisk are BC only)

Integration

- Definite integral as the concept as Riemannian sum
- Indefinite integral as the concept of an antiderivative
- Connection to area
- Integral functions
- Fundamental Theorem of Calculus
- Analytic rules for computation
- Improper integrals*

Integration Applications

- Approximation using LRAM, MRAM, RRAM, and the Trapezoidal Rule
- Rectilinear motion, including displacement and distance traveled
- Total Change Theorem
- Area between curves, including rectangular, parametric*, and polar*
- Volume using cross-sectional slicing, including washers
- Average value of a function, including connection to the Mean Value Theorem
- Arc length*
- Planar motion using vector functions*

Differential Equations

- Solve using antiderivatives
- Solve using separation of variables
- Solve using partial fraction decomposition*
- Slope field analysis
- Approximating numerical solutions using Euler's Method*
- Exponential growth and decay
- Logistic growth*

Series Convergence and Power Series*

- Tests for convergence
- Summation through geometric and telescoping series
- Approximate summation through Alternating Series Estimation Theorem
- Definition of power series, including the radius and interval of convergence
- Function combinations using power series
- Deriving and antideriving power series
- Taylor and Maclaurin series
- Taylor polynomials, including error analysis through graphing, Alternating Series Estimation Theorem, and Taylor's Inequality for the LaGrange Error Bound