# Differentiation Formulas

The following table provides the differentiation formulas for common functions. The first six rows correspond to general rules (such as the addition rule or the product rule) whereas the remaining rows contain the formulas for specific functions.

| | $F(x)$ | $F'(x)$ |
|---|---|---|
| Addition | $f(x) \pm g(x)$ | $f'(x) \pm g'(x)$ |
| Linearity | $af(x)$ | $af'(x)$ |
| Product Rule | $f(x)g(x)$ | $f'(x)g(x) + f(x)g'(x)$ |
| Quotient Rule | $\frac{f(x)}{g(x)}$ | $\frac{f'(x)g(x) - f(x)g'(x)}{(g(x))^2}$ |
| Chain Rule | $f(g(x))$ | $f'(g(x)) \cdot g'(x)$ |
| | $f^{-1}(x)$ | $\frac{1}{f'(f^{-1}(x))}$ |
| Basic functions | $x^n$ for any real $n$ | $nx^{n-1}$ |
| | $e^x$ | $e^x$ |
| | $a^x$ $(a > 0)$ | $(\ln a)a^x$ |
| | $\ln x$ | $\frac{1}{x}$ |
| Trig functions | $\sin x$ | $\cos x$ |
| | $\cos x$ | $-\sin x$ |
| | $\tan x$ | $\frac{1}{\cos^2 x} = 1 + \tan^2 x$ |
| | $\arctan x = \tan^{-1} x$ | $\frac{1}{1+x^2}$ |
| | $\arcsin x = \sin^{-1} x$ | $\frac{1}{\sqrt{1-x^2}}$ |
| Hyperbolic Trig | $\sinh x$ | $\cosh x$ |
| | $\cosh x$ | $\sinh x$ |
| | $\tanh x$ | $\frac{1}{\cosh^2 x}$ |
| | $\sinh^{-1} x$ | $\frac{1}{\sqrt{1+x^2}}$ |
| | $\tanh^{-1} x$ | $\frac{1}{1-x^2}$ |

# Integration Formulas

The following list provides some of the rules for finding integrals and a few of the common antiderivatives of functions.

| | |
|---|---|
| Linearity | $\int af(x) + bg(x)\,dx = a\int f(x)\,dx + b\int g(x)\,dx$ |
| Substitution | $\int f(w(x))w'(x)\,dx = \int f(w)\,dw$ |
| Integration by parts | $\int u(x)v'(x)\,dx = u(x)v(x) - \int u'(x)v(x)\,dx$ |

## Basic Functions

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

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

## Trigonometric functions

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

$$\int \frac{1}{\cos^2 x}\,dx = \tan x + C \qquad \int \tan x\,dx = -\ln|\cos x| + C$$

$$\int \cot x\,dx = \ln|\sin x| + C$$

## Hyperbolic Trig functions

$$\int \sinh x\,dx = \cosh x + C \qquad \int \cosh x\,dx = \sinh x + C$$

$$\int \tanh x\,dx = \ln(\cosh x) + C \qquad \int \coth x\,dx = \ln|\sinh x| + C$$

## Functions with $a^2 \pm x^2$

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

$$\int \frac{dx}{a^2 - x^2} = \frac{1}{2a}\ln\left|\frac{x+a}{x-a}\right| + C$$

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

## Inverse Functions

$$\int \ln x\,dx = x\ln x - x + C \qquad \int \arcsin x\,dx = x\arcsin x + \sqrt{1 - x^2} + C$$

$$\int \arctan x = x\arctan x - \frac{1}{2}\ln(1 + x^2) + C$$