

Differentiation Formulas

Derivatives of Basic Functions

- $\frac{dk}{dx} = 0$; k is a constant
- $\frac{d(x)}{dx} = 1$
- $\frac{d(kx)}{dx} = k$; k is a constant
- $\frac{d(x^n)}{dx} = nx^{n-1}$

Derivatives of Logarithmic and Exponential Functions

- $\frac{d(e^x)}{dx} = e^x$
- $\frac{d(\ln(x))}{dx} = \frac{1}{x}$
- $\frac{d(a^x)}{dx} = a^x \log a$
- $\frac{d(x^x)}{dx} = x^x(1 + \ln x)$
- $\frac{d(\log_a x)}{dx} = \frac{1}{x} \times \frac{1}{\ln a}$

Derivatives of Trigonometric Functions

- $\frac{d(\sin x)}{dx} = \cos x$
- $\frac{d(\cos x)}{dx} = -\sin x$
- $\frac{d(\tan x)}{dx} = \sec^2 x$
- $\frac{d(\cot x)}{dx} = -\operatorname{cosec}^2 x$
- $\frac{d(\sec x)}{dx} = \sec x \tan x$
- $\frac{d(\operatorname{cosec} x)}{dx} = -\operatorname{cosec} x \cot x$

Derivatives of Inverse Trigonometric Functions

- $\frac{d(\sin^{-1} x)}{dx} = \frac{1}{\sqrt{1-x^2}}$
- $\frac{d(\cos^{-1} x)}{dx} = \frac{-1}{\sqrt{1-x^2}}$
- $\frac{d(\tan^{-1} x)}{dx} = \frac{1}{1+x^2}$
- $\frac{d(\cot^{-1} x)}{dx} = \frac{-1}{1+x^2}$

$$\bullet \frac{d(\sec^{-1} x)}{dx} = \frac{1}{|x| \sqrt{x^2 - 1}}$$

$$\bullet \frac{d(\operatorname{cosec}^{-1} x)}{dx} = \frac{-1}{x\sqrt{x^2 - 1}}$$

Differentiation Rules

Product Rule

$$\frac{d}{dx} (f(x) g(x)) = f'(x) g(x) + f(x) g'(x)$$

Quotient Rule

$$\frac{d}{dx} \left(\frac{f(x)}{g(x)} \right) = \frac{f'(x) g(x) - f(x) g'(x)}{(g(x))^2}$$

Chain Rule

$$\frac{d(f(g(x)))}{dx} = f'(g(x)) g'(x)$$

First Derivative Rule

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$