Differentiation Formulas

Derivatives of Basic Functions

- $\dfrac{dk}{dx} = 0$; k is a constant

- $\dfrac{d(x)}{dx} = 1$

- $\dfrac{d(kx)}{dx} = k$; k is a constant

- $\dfrac{d(x^n)}{dx} = nx^{n-1}$

Derivatives of Logarithmic and Exponential Functions

- $\dfrac{d(e^x)}{dx} = e^x$

- $\dfrac{d(\ln(x))}{dx} = \dfrac{1}{x}$

- $\dfrac{d(a^x)}{dx} = a^x \log a$

- $\dfrac{d(x^x)}{dx} = x^x(1 + \ln x)$

- $\dfrac{d(\log_a x)}{dx} = \dfrac{1}{x} \times \dfrac{1}{\ln a}$

Derivatives of Trigonometric Functions

- $$\frac{d(\sin x)}{dx} = \cos x$$

- $$\frac{d(\cos x)}{dx} = -\sin x$$

- $$\frac{d(\tan x)}{dx} = \sec^2 x$$

- $$\frac{d(\cot x)}{dx} = -\csc^2 x$$

- $$\frac{d(\sec x)}{dx} = \sec x \tan x$$

- $$\frac{d(\csc x)}{dx} = -\csc x \cot x$$

Derivatives of Inverse Trigonometric Functions

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

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

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

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

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

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

Differentiation Rules

Product Rule

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

Quotient Rule

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

Chain Rule

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

First Derivative Rule

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