Date : / /

first principle of differentiation

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

OR

$$f'(a) = \lim_{x \to a} \frac{f(x) - f(a)}{x - a}$$

formulae

$$\frac{d}{dx}(\text{constant}) = 0$$

$$\frac{d}{dx}(x) = 1$$

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

$$\frac{d}{dx}\left(\frac{1}{x}\right) = \frac{-1}{x^2}$$

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

$$\frac{d}{dx}(\log_e x) = \frac{1}{x}$$

$$\frac{d}{dx}(\log_a x) = \log_a e \cdot \frac{1}{x}$$

$$\frac{d}{dx} a^x = a^x \log_e a$$

$$\frac{d}{dx} e^x = e^x$$

$$\frac{d}{dx}|x| = \frac{|x|}{x}$$

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

Differentiation using log

let $y = [f(x)]^{g(x)}$

$$\frac{dy}{dx} = y\left[\frac{g(x) f'(x)}{f(x)} + g'(x) \log(f(x))\right]$$

Implicit function

$$\frac{dy}{dx} = -\frac{\text{diff wrt } x, \text{ keep } y \text{ as const}}{\text{diff wrt } y, \text{ keep } x \text{ as const}}$$

$$\frac{d(x^x)}{dx} = x^x(1 + \log x)$$

$$\frac{d}{dx} \sin x = \cos x$$

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

$$\frac{d}{dx} \cot x = -\operatorname{cosec}^2 x$$

$$\frac{d}{dx} \sec x = \tan x \sec x$$

$$\frac{d}{dx} \operatorname{cosec} x = -\operatorname{cosec} x \cot x$$

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

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

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

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

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

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

Rules for differentiation

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

$$\frac{d}{dx}[f(x) \pm g(x)] = \frac{d}{dx} f(x) \pm \frac{d}{dx} g(x)$$

$$\frac{d}{dx} uv = u \frac{d}{dx} v + v \frac{d}{dx} u$$

$$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v \frac{d}{dx} u - u \frac{d}{dx} v}{v^2}$$