Basic Differentiation Formulas

$$\frac{d}{dx}k = 0$$

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

$$\frac{d}{dx}\left[k \cdot f(x)\right] = k \cdot f'(x)$$

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

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

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

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

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

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

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

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

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

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

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

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

$$\frac{d}{dx}\ln|x| = \frac{1}{x}$$

$$\frac{\mathrm{d}}{\mathrm{d}x}[a^x] = (\ln a) \cdot a^x$$

$$\frac{\mathrm{d}}{\mathrm{d}x}[\log_a x] = \frac{1}{x \ln a}$$

Differentiation Rules

Constant-multiple Rule:

$$\frac{\mathrm{d}}{\mathrm{d}x}[kf(x)] = kf'(x)$$

Sum-difference Rule:

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

Power Rule

$$\frac{\mathrm{d}}{\mathrm{d}x}[x^k] = kx^{k-1}$$

Product Rule:

$$\frac{\mathrm{d}}{\mathrm{d}x}[f(x)g(x)] = f(x)g'(x) + f'(x)g(x)$$

Product Rule (three functions):

$$\frac{\mathrm{d}}{\mathrm{d}x}[f(x)g(x)h(x)] = fgh' + fg'h + f'gh$$

Quotient Rule:

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

Reciprocal Rule:

$$\frac{\mathrm{d}}{\mathrm{d}x}\left[\frac{1}{g(x)}\right] = -\frac{g'(x)}{(g(x))^2}$$

Chain Rule:

$$\frac{\mathrm{d}}{\mathrm{d}x}\left[f\left(g(x)\right)\right] = f'\left(g(x)\right) \cdot g'(x)$$

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

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

$$\frac{d}{dx}\left(\frac{v}{C}\right) = \frac{1}{C} \cdot \frac{dv}{dx}$$

$$\frac{d}{dx}\left(\sqrt{u}\right) = \frac{\dfrac{du}{dx}}{2\sqrt{u}}$$

$$\frac{d}{dx}\left(u^{\frac{1}{n}}\right) = \frac{1}{n} \cdot u^{\frac{1}{n}-1}\frac{du}{dx}$$

Exponential Functions

$$\frac{d}{dx}\left(e^{x}\right) = e^{x}$$

$$\frac{d}{dx}\left(a^{x}\right) = a^{x} \ln a$$

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

$$\frac{d}{dx}\left(a^{g(x)}\right) = \ln(a)\, a^{g(x)}\, g'(x)$$

Logarithmic Functions

$$\frac{d}{dx}(\ln x) = \frac{1}{x}, x > 0$$

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

$$\frac{d}{dx}\left(\log_a x\right) = \frac{1}{x \ln a}, x > 0$$

$$\frac{d}{dx}\left(\log_a g(x)\right) = \frac{g'(x)}{g(x)\ln a}$$

Trigonometric Functions

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

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

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

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

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

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

Inverse Trigonometric Functions

$$\frac{d}{dx}\left(\sin^{-1} x\right) = \frac{1}{\sqrt{1-x^2}}, x \neq \pm 1$$

$$\frac{d}{dx}\left(\cos^{-1} x\right) = \frac{-1}{\sqrt{1-x^2}}, x \neq \pm 1$$

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

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

$$\frac{d}{dx}\left(\sec^{-1} x\right) = \frac{1}{x\sqrt{x^2-1}}, x \neq \pm 1, 0$$

$$\frac{d}{dx}\left(\csc^{-1} x\right) = \frac{-1}{x\sqrt{x^2-1}}, x \neq \pm 1, 0$$

Hyperbolic Functions

$$\frac{d}{dx}(\sinh x) = \cosh x$$

$$\frac{d}{dx}(\cosh x) = \sinh x$$

$$\frac{d}{dx}(\tanh x) = \operatorname{sech}^2 x$$

$$\frac{d}{dx}(\operatorname{csch} x) = -\operatorname{csch} x \coth x$$

$$\frac{d}{dx}(\operatorname{sech} x) = -\operatorname{sech} x \tanh x$$

$$\frac{d}{dx}(\coth x) = -\operatorname{csch} x$$

Inverse Hyperbolic Functions

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

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

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

$$\frac{d}{dx}\left(\operatorname{csch}^{-1} x\right) = \frac{-1}{|x|\sqrt{1-x^2}}, x \neq 0$$

$$\frac{d}{dx}\left(\operatorname{sech}^{-1} x\right) = \frac{-1}{x\sqrt{1-x^2}}, 0 < x < 1$$

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