

# Differentiation

## Base Differentiation Rules

1.  $\frac{d}{dx} c = 0$  where  $c$  is a constant
2.  $\frac{d}{dx} x = 1$
3.  $\frac{d}{dx} f(x) = f'(x)$
4. Power Rule:  $\frac{d}{dx} x^n = nx^{n-1}$
5. Constant Multiple Rule:  $\frac{d}{dx} cf(x) = cf'(x)$
6. Sum Rule:  $\frac{d}{dx} [f(x) + g(x)] = f'(x) + g'(x)$
7. Product Rule:  $\frac{d}{dx} [f(x)g(x)] = f'(x)g(x) + f(x)g'(x)$
8. Quotient Rule:  $\frac{d}{dx} \left[ \frac{f(x)}{g(x)} \right] = \frac{f'(x)g(x) - f(x)g'(x)}{[g(x)]^2}$

## Derivatives of Trigonometric Functions

9.  $\frac{d}{dx} \sin(x) = \cos(x)$
10.  $\frac{d}{dx} \cos(x) = -\sin(x)$
11.  $\frac{d}{dx} \tan(x) = \sec^2 x$
12.  $\frac{d}{dx} \cot(x) = -\csc^2 x$
13.  $\frac{d}{dx} \sec(x) = \sec(x) \tan(x)$
14.  $\frac{d}{dx} \csc(x) = -\csc(x) \cot(x)$

**Advanced Differentiation Rules**

15. Exponential:  $\frac{d}{dx} a^x = \ln(a) a^x$

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

16. Logarithmic:  $\frac{d}{dx} \log_a(x) = \frac{1}{x \ln(a)}$

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

17. Chain Rule:  $\frac{d}{dx} f(g(x)) = f'(g(x))g'(x)$

a. General Power Rule:  $\frac{d}{dx} [f(x)]^n = n[f(x)]^{n-1}f'(x)$

b. General Trigonometric Rule:  $\frac{d}{dx} \sin(f(x)) = \cos(f(x))f'(x)$

c. General Exponential Rule:  $\frac{d}{dx} a^{f(x)} = \ln(a) a^{f(x)} f'(x)$

d. General Logarithmic Rule:  $\frac{d}{dx} \log_a(f(x)) = \frac{f'(x)}{f(x) \ln(a)}$

**Derivatives of Hyperbolic Functions**

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

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

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

21.  $\frac{d}{dx} \coth(x) = -\operatorname{csch}^2(x)$

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

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

**Derivatives of Inverse Functions**

24. Inverse: Where  $I(x)$  is the inverse of  $f(x)$ ,  $I'(x) = \frac{1}{f'(I(x))}$

$$25. \frac{d}{dx} \arcsin(x) = \frac{1}{\sqrt{1-x^2}}$$

$$26. \frac{d}{dx} \arccos(x) = \frac{-1}{\sqrt{1-x^2}}$$

$$27. \frac{d}{dx} \arctan(x) = \frac{1}{1+x^2}$$

$$28. \frac{d}{dx} \operatorname{arccot}(x) = \frac{-1}{1+x^2}$$

$$29. \frac{d}{dx} \operatorname{arcsec}(x) = \frac{1}{|x|\sqrt{x^2-1}}$$

$$30. \frac{d}{dx} \operatorname{arccsc}(x) = \frac{-1}{|x|\sqrt{x^2-1}}$$

$$31. \frac{d}{dx} \operatorname{arcsinh}(x) = \frac{1}{\sqrt{1+x^2}}$$

$$32. \frac{d}{dx} \operatorname{arccosh}(x) = \frac{1}{\sqrt{x^2-1}}$$

$$33. \frac{d}{dx} \operatorname{arctanh}(x) = \frac{1}{1-x^2}$$

$$34. \frac{d}{dx} \operatorname{arccoth}(x) = \frac{1}{1-x^2}$$

$$35. \frac{d}{dx} \operatorname{arcsech}(x) = \frac{-1}{x\sqrt{1-x^2}}$$

$$36. \frac{d}{dx} \operatorname{arccsch}(x) = \frac{-1}{|x|\sqrt{x^2+1}}$$