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Derivatives of Functions

Differentiation is a cornerstone concept in calculus, facilitating the analysis of rates of change. This paper explores the derivatives of trigonometric, inverse trigonometric, logarithmic and exponential, and hyperbolic functions. The aim is to elucidate their formulas, properties, and practical applications.

Derivatives of Trigonometric Functions

Trigonometric functions such as sine, cosine, and tangent have well-defined derivatives derived using the fundamental principles of calculus. These derivatives are crucial in physics, engineering, and other fields. The basic rules are as follows:

- $(sin\,x)' = cos\,x$
- $(cos\,x)' =- sin\,x$
- $(tan\,x)' = sec^2\,x$
- $(cot\,x)' =- csc^2\,x$
- $(sec\,x)' = sec\,x \cdot tan\,x$
- $(csc\,x)' =- csc\,x \cdot cot\,x$

For example, differentiating $y = cos(2x)$ involves the chain rule, yielding:

$$y' =- sin(2x) \cdot 2 =- 2sin(2x)$$

Derivatives of Inverse Trigonometric Functions

Inverse trigonometric functions, useful in geometry and modeling scenarios, have derivatives derived via implicit differentiation. Their formulas include:

- $(arcsin\,x)' = \frac{1}{\sqrt{1-x^2},}$ valid for $-1 < x < 1$
- $(arccos\,x)' = \frac{1}{\sqrt{1-x^2},}$ valid for $-1 < x < 1$
- $(arctan\,x)' = \frac{1}{\sqrt{1-x^2},}$ valid for $x \in R$

As an example, differentiating $y = arctan(3x)$ gives:

$$y' = \frac{1}{1+(3x)^2} \cdot 3 = \frac{3}{1+9x^2}$$

Derivatives of Logarithmic and Exponential Functions

Logarithmic and exponential functions are fundamental in growth modeling, decay processes, and compound interest calculations. Their derivatives are:

- $(e^x)' = e^x$
- $(lnx)' = \frac{1}{x}$, valid for $x > 0$
- For general bases: $(ax)' = a^x \, ln\, a,\ (loga\, x)' = \frac{1}{x\, ln\, a}$

For Instance, for $y = ln(5x)$:

$$y' = \frac{1}{5x} \cdot 5 = \frac{1}{x}$$

Derivatives of Hyperbolic Functions

Hyperbolic functions, which resemble trigonometric functions but with different applications in hyperbolic geometry and relativity, have the following derivatives:

- $(sinh\, x)' = cosh\, x$
- $(cosh\, x)' =- sinh\, x$
- $(tanh\, x)' = sech^2\, x$

An example is $y = sinh(2x)$, whose derivative is:

$$y' = cosh(2x) \cdot 2 = 2cosh(2x)$$
