INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCHERS
Volume 1,issue 1,2023

THE DERIVATIVE OF THE TRIGONOMETRIC FUNCTION

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Annotation: This article to present the derivatives of the trigonometric functions, along with their proofs. It involves some formulas to solve trigonometric functions.

Key words: trigonometric functions, derivative, formulas.

The process of finding the derivatives of trigonometric functions is known as the differentiation of trigonometric functions. In other words, the differentiation of trigonometric functions is finding the rate of change of the function with respect to the variable. The six trigonometric functions have differentiation formulas that can be used in various application problems of the derivative.

The six basic trigonometric functions include the following: sine (sin x), cosine (cos x), tangent (tan x), cotangent (cot x), secant (sec x) and cosecant (cosec x). In this article, we will find the derivatives of the trigonometric functions and their proofs. Differentiation of trigonometric functions have applications in different fields such as electronics, computer programming and modeling different cyclic functions.

In trigonometry, differentiation of trigonometric functions is a mathematical process of determining the rate of change of the trigonometric functions with respect to the variable angle. The differentiation of trigonometric functions can be done using the derivatives of sin x and cos x by applying the quotient rule. The differentiation formulas of the six trigonometric functions are listed below:

- Derivation of sin x: $(\sin x)' = \cos x$
- Derivative of cos x: $(\cos x)' = -\sin x$
- Derivative of tan x: $(\tan x)' = \sec^2 x$
- Derivative of cot x: $(\cot x)' = -\text{cosec}^2 x$
- Derivative of sec x: $(\sec x)' = \sec x.\tan x$
- Derivative of cosec x: $(\text{cosec } x)' = -\text{cosec } x.\cot x$

We use d/dx to write the derivatives. Here are the tri derivatives using this notation.

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

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

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

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

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

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

Proofs of Trig Derivatives

Now, that we have the differentiation of trigonometric functions (sin x, cos x, tan x, cot x, sec x, cosec x), we will prove and derive the trig derivatives using various methods such as the quotient rule, the first principle of differentiation, and chain rule along with some limit formulas.

We will determine the derivative of tan x using the quotient rule. We will use the following formulas and identities to calculate the derivative:

- (sin x)' = cos x
- (cos x)' = -sin x
- tan x = sin x/ cos x
- $\cos^2 x + \sin^2 x = 1$
- sec x = 1/cos x

(tan x)' = (sin x/cos x)'
= [(sin x)' cos x - (cos x)' sin x]/$\cos^2 x$
= [cos x. cos x - (-sin x). sin x]/$\cos^2 x$
= ($\cos^2 x + \sin^2 x$)/$\cos^2 x$
= 1/$\cos^2 x$
= $\sec^2 x$
Therefore, d(tan x)/dx = $\sec^2 x$

Derivative of cot x

We will determine the derivative of cot x using the quotient rule. We will use the following formulas and identities to calculate the derivative:

- (sin x)' = cos x
- (cos x)' = -sin x
- cot x = cos x/ sin x
- $\cos^2 x + \sin^2 x = 1$
- cosec x = 1/sin x

(cot x)' = (cos x/sin x)'
= [(cos x)' sin x - (sin x)' cos x]/$\sin^2 x$
= [-sin x. sin x - cos x. cos x]/$\sin^2 x$
= (-$\sin^2 x$ - $\cos^2 x$)/$\sin^2 x$
= -1/$\sin^2 x$
= -$\text{cosec}^2 x$
Therefore, d(cot x)/dx = -$\text{cosec}^2 x$

Derivative of sec x

We will determine the derivative of sec x using the chain rule. We will use the following formulas and identities to calculate the derivative:

- sec x = 1/cos x
- tan x = sin x/cos x
- (cos x)' = -sin x

(sec x)' = (1/cos x)' = (-1/$\cos^2 x$).(cos x)'
= (-1/$\cos^2 x$).(-sin x)

= sin x/cos^{2}x
= (sin x/cos x).(1/cos x)
= tan x sec x
Therefore, d(sec x)/dx = tan x sec x
Derivative of cosec x
We will determine the derivative of cosec x using the chain rule. We will use the following formulas and identities to calculate the derivative:

- cosec x = 1/sin x
- cot x = cos x/sin x
- (sin x)' = cos x

(cosec x)' = (1/sin x)' = (-1/sin^{2}x).(sin x)'
= (-1/sin^{2}x).(cos x)
= -cos x/sin^{2}x
= -(cos x/sin x).(1/sin x)
= -cot x cosec x
Therefore, d(cosec x)/dx = -cot x cosec x
Applications of Differentiation of Trigonometric Functions
The differentiation of trigonometric functions has various applications in the field of mathematics and real life. Some of them are listed below:

- It is used to determine the slope of the tangent line to a trigonometric curve y = f(x).
- It is used to determine the slope of the normal line to a trigonometric curve y = f(x).
- It helps to determine the equation of the tangent line or normal line of a curve.
- Differentiation of trigonometric functions have applications in different fields such as electronics, computer programming and modeling different cyclic functions.
- We use the derivatives of trigonometric functions to determine the maximum and minimum values of particular functions.

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