

# Introduction to Calculus

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## 1 Limits and Continuity

Calculus begins with the concept of limits and continuity.

### 1.1 Limit

The limit of a function  $f(x)$  at a point  $x = a$  is defined as:

$$\lim_{x \rightarrow a} f(x) = L$$

if for every  $\varepsilon > 0$ , there exists a  $\delta > 0$  such that if  $0 < |x - a| < \delta$ , then  $|f(x) - L| < \varepsilon$ .

### 1.2 Continuity

A function  $f(x)$  is continuous at a point  $x = a$  if the following three conditions hold:

1.  $f(a)$  is defined.
2.  $\lim_{x \rightarrow a} f(x)$  exists.
3.  $\lim_{x \rightarrow a} f(x) = f(a)$ .

## 2 Derivatives

The derivative of a function measures its rate of change.

### 2.1 Derivative Definition

The derivative of a function  $f(x)$  at a point  $x = a$  is defined as:

$$f'(a) = \lim_{h \rightarrow 0} \frac{f(a+h) - f(a)}{h}$$

## 2.2 Differentiability

A function  $f(x)$  is differentiable at a point  $x = a$  if the derivative  $f'(a)$  exists.

## 3 Integrals

Integrals are used to calculate the accumulated area under a curve.

### 3.1 Definite Integral

The definite integral of a function  $f(x)$  over the interval  $[a, b]$  is denoted as:

$$\int_a^b f(x) dx$$

### 3.2 Indefinite Integral

The indefinite integral of a function  $f(x)$  is denoted as:

$$\int f(x) dx$$

## 4 Conclusion

Calculus is a fundamental branch of mathematics that deals with limits, continuity, derivatives, and integrals. These concepts form the basis for understanding changes and accumulation in various mathematical and scientific fields.