Section 3.1

I. Secant Line through $\left(x_0, f(x_0)\right)$ to $\left(x_0 + \Delta x, f(x_0 + \Delta x)\right)$

Secant Line through $\left(x_0, f(x_0)\right)$ to $\left(x_1, f(x_1)\right)$

a. $$\frac{\Delta y}{\Delta x} = \frac{f(x_0 + \Delta x) - f(x_0)}{\Delta x} = \frac{f(x_1) - f(x_0)}{x_1 - x_0}$$

b. Difference Quotient

c. Slope of Secant line

d. Average Rate of Change of f over the interval $[x_0, x_0 + \Delta x]$

II. Tangent Line = Limiting Case of Secant Line through $\left(x_0, f(x_0)\right)$ to $\left(x_0 + \Delta x, f(x_0 + \Delta x)\right)$

Tangent Line = Limiting Case of Secant Line through $\left(x_0, f(x_0)\right)$ to $\left(x_1, f(x_1)\right)$

a. $$\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(x_0 + \Delta x) - f(x_0)}{\Delta x} = \lim_{x_1 \to x_0} \frac{f(x_1) - f(x_0)}{x_1 - x_0} = f'(x_0)$$

b. Derivative = $\lim\limits_{\Delta x \to 0}$ Difference Quotient

c. Slope of Tangent Line = $\lim\limits_{\Delta x \to 0}$ Slope of Secant Line

d. Instantaneous Rate of Change of f at x_0 = $\lim\limits_{\Delta x \to 0}$ Average Rate of Change of f over the interval $[x_0, x_0 + \Delta x]$

Examples

III. Definition of Derivative of f at x

Examples

IV. Equation of Tangent Line to a curve $y = f(x)$ at $x = x_0$

Equation of Normal Line to a curve $y = f(x)$ at $x = x_0$

Examples

V. Relationship between f and f'

VI. Existence of Derivative

VII. Differentiability and Continuity