2.6 Higher-order Derivatives

2^{nd} Derivative:

$\frac{d}{dx}[f'(x)] = f''(x)$ Second Derivative

3^{rd} Derivative

$\frac{d}{dx}[f''(x)] = f'''(x)$ Third Derivative

Etc.

Notation

1. 1^{st} Derivative y', $f'(x)$, $\frac{dy}{dx}$ ~~dy~~ $\frac{d}{dx}[f(x)]$

2. 2^{nd} Derivative y'' $f''(x)$ $\frac{d^2y}{dx^2}$ $\frac{d^2}{dx^2}[f(x)]$

3. 3^{rd} Derivative y''' $f'''(x)$ $\frac{d^3y}{dy^3}$ $\frac{d^3}{dx^3}[f(x)]$

Etc.

Ex. 1   Find the first 4 derivatives of

a) $f(x) = 6x^3 - 2x^2 + 1$ b) $y = \frac{1}{x}$

Applications:

Acceleration: The rate of change of the velocity with respect to time.

$s = f(t)$ Position func

$v(t) = \frac{ds}{dt} = f'(t)$ Velocity func.

$a(t) = v'(t) = \frac{d^2s}{dt^2} = f''(t)$ Acceleration func.

Ex. 2 Finding Acceleration

A ball is thrown upward from the top of an 80 ft cliff with an initial velocity of 64 ft per sec. Give the position function. Find the velocity and acceleration functions.

Find the height, the velocity, and the acceleration at $t = 2$ sec.

Ex. 3 The velocity v (in ft/sec.) of a certain automobile starting from rest is $v = \dfrac{80t}{t+5}$ t - time in s.

Find velocity and acceleration at $t=0$, $t=10$.

2.7 Implicit Differentiation

So far we ~~have~~ found derivatives $\frac{dy}{dx}$ explicitly.

Find $\frac{dy}{dx}$ if $xy = 1$

But if y is not a function of x, this method does not work $\Rightarrow$ implicit differentiation

We must apply the chain rule.

Example: Differentiate with respect to x

a) $3x^2$ b) $2y^3$ c) $x + 3y$ d) xy^2

Ex. Find the slope of the tangent line to the circle $x^2+y^2=25$ at the point $(3,-4)$

Ex. Differentiate Find $\frac{dy}{dx}$ for the equation

$$y^3+y^2+x^2-2y-4x=7$$

Ex. Find the slope of the graph at the point $(5,1)$

$$x^2-9y^2=16$$