

## 3.5 Derivatives of Trigonometric Functions

Derivative formulas for sine and cosine:

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

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

### Example 1 Revisiting the Differentiation Rules

Find the derivative of

a)  $y = 2 + 3 \sin x - \cos x$

b)  $y = x^2 \sin x$

c)  $y = \frac{x}{1 + \cos x}$

d)  $y = \frac{\cos x}{1 - \sin x}$

## Simple Harmonic Motion

### Example 2 The Motion of a Weight on a Spring

A weight hanging from a spring is stretched 5 units beyond its rest position ( $s = 0$ ) and released at time  $t = 0$  to bob up and down. Its position at any later time  $t$  is:

$$s = 5 \cos t$$

What is its velocity and acceleration at time  $t$ ? Describe its motion.

### Definition: Jerk

A sudden change in acceleration is called a “jerk”. A Jerk is the derivative of acceleration.

$$j(t) = \frac{da}{dt} = \frac{d^3s}{dt^3}$$

**Example 3: Determine the Jerk from Example 2:**

### Derivatives of Other Basic Trigonometric Functions

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

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

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

$$\frac{d}{dx}(\csc x) =$$

**Proof:**

#### **Example 4 Finding Tangent and Normal Lines**

Find the equations for the lines that are tangent to the graph of  $f(x) = \frac{\tan x}{x}$  at  $x = 2$ .

#### **Example 5 :**

**Try:**

a.) Find  $y'$  if  $y = \frac{5}{\sin x}$

b.) Find  $y''$  if  $y = \sec x$

c.) Find the 325<sup>th</sup> derivative of  $y = \sin x$