Differentiation Techniques

Notation:		
$f(x)$	y	y
$f'(x)$	y'	$\frac{dy}{dx}$ 1st Deriv.
$f''(x)$	y''	$\frac{d^2y}{dx^2}$ 2nd Deriv.

Note: $\frac{d}{dx}(f(x))$ means "find the derivative of $f(x)$"

Universal Rules:

Chain Rule (for composition)

$$\frac{d}{dx}f(g(x)) = f'(g(x))\cdot g'(x)$$

$$\frac{d}{dx}(y) = \frac{dy}{du}\cdot\frac{du}{dx}$$

$u(x)$

"Derivative of outer function times the derivative of the inner function"

Product Rule: (for Multiplication)

$$\frac{d}{dx}(f(x)\cdot g(x)) = f'(x)\cdot g(x) + g'(x)\cdot f(x)$$

$$\frac{d}{dx}(u\cdot v) = u\cdot v' + u'v$$

Quotient Rule: (for Division)

$$\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) = \frac{g(x)f'(x) - f(x)g'(x)}{[g(x)]^2}$$

$$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\cdot u' - u\cdot v'}{v^2}$$

Specific Functions

Common Derivatives

$$\frac{d}{dx}(c) = 0$$

$$\frac{d}{dx}(ax) = a$$

$$\frac{d}{dx}(x) = 1$$

$$\frac{d}{dx}\left(\frac{1}{u}\right) = \frac{-1}{u^2}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}(\sqrt{u}) = \frac{1}{2\sqrt{u}}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}(u^a) = a\cdot u^{a-1}\cdot\frac{du}{dx}$$

Exponents and Logarithms

$$\frac{d}{dx}(e^u) = e^u\cdot\frac{du}{dx}$$

$$\frac{d}{dx}(a^u) = a^u\cdot\frac{du}{dx}\cdot\ln(a)$$

$$\frac{d}{dx}(\ln u) = \frac{1}{u}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}(\log_a u) = \frac{1}{u}\cdot\frac{du}{dx}\cdot\frac{1}{\ln(a)}$$

Trigonometric Functions

$$\frac{d}{dx}(\sin u) = \cos u\cdot\frac{du}{dx} \qquad \frac{d}{dx}(\cos u) = -\sin u\cdot\frac{du}{dx}$$

$$\frac{d}{dx}(\tan u) = \sec^2 u\cdot\frac{du}{dx} \qquad \frac{d}{dx}(\cot u) = -\csc^2 u\cdot\frac{du}{dx}$$

$$\frac{d}{dx}(\sec u) = \sec u\cdot\tan u\cdot\frac{du}{dx}$$

$$\frac{d}{dx}(\csc) = -\csc u\cdot\cot u\cdot\frac{du}{dx}$$

Inverse Trig Functions

$$\frac{d}{dx}\sin^{-1}u = \frac{1}{\sqrt{1-u^2}}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}\cos^{-1}u = \frac{-1}{\sqrt{1-u^2}}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}\tan^{-1}u = \frac{1}{1+u^2}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}\sec^{-1}u = \frac{1}{|u|\sqrt{u^2-1}}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}\csc^{-1}u = \frac{-1}{|u|\sqrt{u^2-1}}\cdot\frac{du}{dx}$$

$$\frac{d}{dx}\cot^{-1}u = \frac{-1}{1+u^2}\cdot\frac{du}{dx}$$