$$\frac{d}{dx}\left(\cos\left(\tan(x^3)\right)\right) = -\sin\left(\tan(x^3)\right)\cdot\left(\tan(x^3)\right)'$$
$$= -\sin(\tan(x^3))\cdot\sec^2(x^3)\cdot 3x^2$$

$\frac{d}{dx}[sin(x)] = cos(x)$ $\frac{d}{dx}[cos(x)] = -sin(x)$

$\frac{d}{dx}[tan(x)] = sec^2(x)$

$\frac{d}{dx}(sin^{-1}x) = \frac{1}{\sqrt{1-x^2}}$ $\frac{d}{dx}(cos^{-1}x) = \frac{-1}{\sqrt{1-x^2}}$

$\frac{d}{dx}(tan^{-1}x) = \frac{1}{1+x^2}$

Ex: $\frac{d}{dx}(cos^{-1}(tan^{-1}(x^3)))$

$$= \frac{-1}{\sqrt{1-\left(\tan^{-1}(x^3)\right)^2}}\cdot\left(\tan^{-1}(x^3)\right)'$$

$$= \frac{-1}{\sqrt{1-[\tan^{-1}(x^3)]^2}}\cdot\frac{1}{1+(x^3)^2}\cdot 3x^2$$

Ex: $\boxed{\frac{d}{dx}(ln(x)) = 1/x}$

$y = \ln x$

$$e^y = e^{\ln x}$$

$$\frac{d}{dx}(e^y) = \frac{d}{dx}(x)$$

$$e^y = x$$

$$e^y\cdot\frac{dy}{dx} = 1$$

$$\frac{dy}{dx} = \frac{1}{e^y} = \frac{1}{x}$$

$$2x^2 \cdot y - 3y^2 = 4$$

To find y'' first find y'

$$4x \cdot y + 2x^2 \cdot \frac{dy}{dx} - 6y \cdot \frac{dy}{dx} = 0$$

Solve for y':

$$\frac{dy}{dx}\left(2x^2 - 6y\right) = -4xy$$

$$\frac{dy}{dx} = \frac{-4xy}{2x^2 - 6y} \, \frac{(-1)}{(-1)} = \frac{4xy}{6y - 2x^2}$$

Find y''

$$y'' = \frac{d^2y}{dx^2} = \frac{(6y-2x^2)\{4(xy)\}' - 4xy\,(6y-2x^2)'}{(6y-2x^2)^2}$$

$$= \frac{(6y-2x^2)(4)\left(1y + x\frac{dy}{dx}\right) - 4xy\left(6\frac{dy}{dx} - 4x\right)}{(6y-2x^2)^2}$$

~~Substitute~~ Get rid of $\frac{dy}{dx}$ via substitution

$$y'' = \frac{(6y-2x^2)(4)\left(y + x\left(\frac{4xy}{6y-2x^2}\right)\right) - 4xy\left(6\left(\frac{4xy}{6y-2x^2}\right) - 4x\right)}{(6y-2x^2)^2}$$

3.7

Suppose $s(t) = t^2 + 3t - 1$ represents position at time t.

Then velocity $= v(t) = \frac{d}{dt}(s(t)) = s'(t) = 2t + 3$

and acceleration $= a(t) = \frac{d}{dt}(v(t)) = v'(t) = s''(t) = 2$

$\uparrow$ 2nd derivative

jerk = change in acceleration
$= D(a(t)) = \frac{d}{dt}(a(t)) = a'(t) = v''(t) = s'''(t) = 0$

$\uparrow$ 3rd derivative

Ex: Find $\frac{d^{50}}{dx^{50}}(sin(x)) = -\sin(x)$

$[\sin(x)]' = \cos(x)$

$[\sin(x)]'' = (\cos(x))' = -\sin(x)$

$[\sin(x)]''' = (-\sin(x))' = -\cos(x)$

$[\sin(x)]^{iv} = (-\cos(x))' = \sin(x)$

$[\sin(x)]^{v} = (\sin(x))' = \cos(x)$

$$\frac{d}{dt}\left(\frac{d}{dt}\left(\frac{d}{dt}(s(t))\right)\right) = \frac{d^3}{dt^3}(s(t)) = D^3(s(t)) = s'''(t) = s^{(3)}(t)$$

$\uparrow$ take 3rd derivative

Ex: Find y'' if $2x^2y - 3y^2 = 4$

$s^{(40)}(t) = 0$

$\uparrow$ 40th derivative

$s^{(n)}(t) = 0$ if $n \geq 3$