→ optional, if it helps.

§3.6 #s $\boxed{1-4, 9-12}$, 19-26, 37-44, 58-60,

65, 67, 73, 79

→ optional

$$\frac{d}{dx}\left[\left(x^5+\sin x\right)^{37}\right] = 37\left(x^5+\sin x\right)^{36}\left(5x^4+\cos x\right)$$

$$\frac{d}{dt}\left[\cos\left(27t^2-15t\right)\right] = \underbrace{\left(-\sin\left(27t^2-15t\right)\right)}_{\text{Derivative of the outside w.r.t. the inside}}\left(54t-15\right)$$

Derivative of the outside w.r.t. the inside

TIMES

Derivative of the inside with respect to the variable

My profit function is
$P(x) = 2x^2 - 3x$ (in \$), where
x = the # of shirts I'm making.

Suppose $x = 5t$, where t = time in hours

How fast am I making money?
What's the rate of money change as a function of time?

Want $\frac{dP}{dt}$

$\frac{dP}{dx} = 4x - 3$

But I want $\frac{dP}{dt}$.

We know $x = 5t$

So $P(x) = P(x(t)) = 2x^2 - 3x = 2(5t)^2 - 3(5t)$
$= 50t^2 - 15t = P(t)$.

$$\frac{dP}{dt} = 100t - 15$$
$$= 5(20t - 3)$$
$$= 5(4(5t) - 3)$$
$$= 5(4x - 3)$$
$$= (4x-3)(5)$$
$$= \frac{dP}{dx} \cdot \frac{dx}{dt}$$

$$\frac{d}{dt}\left[P(x(t))\right]$$
$$= \frac{dP}{dx} \cdot \frac{dx}{dt}$$
$$= P'(x)\, x'(t)$$

prime wrt x w.r.t. t

$$\left(f(g(x))\right)'$$
$$= f'(g)\, g'(x)$$

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$$f(x) = \cos^2(5x)$$
$$= (\cos(5x))^2$$

$$\Rightarrow f'(x) = \underbrace{2(\cos(5x))'}\ \underbrace{(-\sin(5x))}\ \underbrace{(5)}$$

$$\boxed{\frac{d\left((\cos(5x))^2\right)}{d(\cos(5x))} \cdot \frac{d(\cos(5x))}{d(5x)} \cdot \frac{d(5x)}{dx}}$$

we have $f(g(h(x)))$, where

$f(g) = g^2$

$g(h) = \cos(h)$

$h(x) = 5x$

$$\frac{d}{dx}\left[f(g(h(x)))\right] = \frac{df}{dg} \cdot \frac{dg}{dh} \cdot \frac{dh}{dx}$$

$$\frac{d}{dx}\left[\tan\left(\sin\left(x^2-\sqrt{x}\right)\right)\right]$$

$$=\sec^2\left(\sin\left(x^2-\sqrt{x}\right)\right)\left(\cos\left(x^2-\sqrt{x}\right)\right)\left(2x-\frac{1}{2\sqrt{x}}\right)$$

$$\frac{d}{dx}\left[\sqrt{x}\right]=\frac{d}{dx}\left[x^{\frac{1}{2}}\right]=\frac{1}{2}x^{-\frac{1}{2}}=\frac{1}{2}\cdot\frac{1}{\sqrt{x}}=$$

§3.4

Speed = |velocity|

$s(t)$ = position

$s'(t)$ = velocity $= v(t)$

$s''(t)$ = acceleration $= v'(t) = a(t)$

$s'''(t)$ = jerk $= j(t)$

$$\frac{t^4}{4} = \frac{1}{4}t^4$$

$$\frac{d}{dt}\left[\frac{t^4}{4}\right] = \frac{4t^3 - t^4 \cdot 0}{4^2} = \frac{4t^3}{4} = t^3 \text{ owie!}$$

$$4 \cdot \tfrac{1}{4}t^3 = t^3$$

(3) $s(t) = -t^3 + 3t^2 - 3t \quad t \in [0,3]$

(a) $s(3) - s(0) = \Delta s$

$$= -3^3 + 3(3)^2 - 3(3) = -27 + 27 - 9 = -9 \text{ m}$$

$$V_{AVG} = \frac{s(3) - s(0)}{3 - 0} = \frac{-9}{3} = -3 \text{ m/s}$$

(b) speed $= |v(t)|$

$v(t) = -3t^2 + 6t - 3$

$|v(0)| = |-3| = 3$ m/s

$|v(3)| = |-3(3)^2 + 6(3) - 3| = |-27 + 18 - 3| = |-12|$

$= 12$ m/s.

$a(t) = v'(t) = s''(t)$

$= -6t + 6 \longrightarrow$

$a(0) = 6$ m/s²

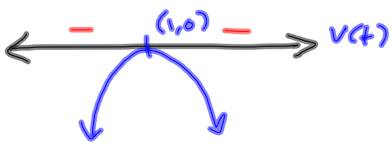
$a(3) = -6(3) + 6 = -12$ m/s²

(c) $v(t) = -3t^2 + 6t - 3 \overset{\text{set}}{=} 0$

$= -3(t^2 - 2t + 1) = 0 \Longrightarrow$

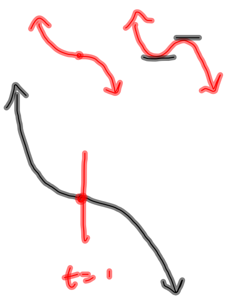
$t^2 - 2t + 1 = 0$

$(t-1)^2 = 0$



So this is really

$v(t) = -3(t-1)^2$



So s(t) is doing this:

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① $\frac{d}{dx}[\sin x] =$

② $\frac{d}{dx}[\cos x] =$

③ $\frac{d}{dx}[\tan x] =$

④ $\frac{d}{dx}[\sec x] =$

⑤ $\frac{d}{dx}[\csc x] =$

⑥ $\frac{d}{dx}[\cot x] =$

① $\cos x$

② $-\sin x$

③ $\sec^2 x$

④ $\sec x \tan x$

⑤ $-\csc x \cot x$

⑥ $-\csc^2 x$

$$\frac{d}{dx}[\sec x] = \frac{d}{dx}\left[\frac{1}{\cos x}\right] = \frac{d}{dx}\left[(\cos x)^{-1}\right]$$

$$= -(\cos x)^{-2}(-\sin x)$$

$$= \frac{\sin x}{\cos^2 x} = \frac{1}{\cos x} \cdot \frac{\sin x}{\cos x} = \sec x \tan x$$

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1. $\cos x$
2. $-\sin x$
3. $\sec^2 x$
4. $\sec x \tan x$
5. $-\csc x \cot x$
6. $-\csc^2 x$