$$\frac{d}{dx}[C] = 0 \qquad \frac{d}{dx}[x^n] = n \cdot x^{n-1}$$

$$\frac{d}{dx}[\pi] = 0 \qquad \frac{d}{dx}\left[\frac{1}{x^n}\right] = -\frac{1}{x^{n+1}}$$

$$\frac{d}{dx}[\pi^e] = 0 \qquad \frac{d}{dx}\sqrt{x} = \frac{1}{2\sqrt{x}}$$

$$\frac{d}{dx}[\sin u] = \cos u \cdot u'$$

$$\frac{d}{dx}[\cos u] = -\sin u \cdot u'$$

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

$$\frac{d}{dx}[\cot u] = -\csc^2(u) \cdot u'$$

$$\frac{d}{dx}[\sec u] = \sec u \cdot \tan u \cdot u' \qquad \left(\sec = \frac{1}{\cos}\right)$$

$$\frac{d}{dx}[\csc u] = -\csc u \cdot \cot u \cdot u'$$

$$\frac{d}{dx}[\ln u] = \frac{u'}{u}$$

$$\frac{d}{dx}\left[\log_a u\right] = \frac{u'}{u \cdot \ln a}$$

$$\frac{d}{dx}\left[e^{u}\right] = e^{u} \cdot u'$$

$$\frac{d}{dx}\left[a^{u}\right] = a^{u} \cdot u' \cdot \ln(a)$$

$$\frac{d}{dx}\left[u \cdot v\right] = u' \cdot v + u \cdot v'$$

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

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

$$\frac{d}{dx}\left[x^{x}\right] =$$

1. $y = x^x$
2. $\ln y = \ln(x^x)$

   $\ln y = x \ln x$

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

$$\frac{1}{y} \cdot \frac{dy}{dx} = \ln x + x\left(\frac{1}{x}\right) \Big| \cdot y$$

$$\frac{dy}{dx} = y\left[1 + \ln x\right]$$

$$\frac{dy}{dx} = x^x\left[1 + \ln x\right]$$

Find tangent line equation

(1) $f(x) = 2x^2 - 5x + 3$ at $x_1 = 2$

$y - y_1 = m(x - x_1)$

$y_1 = 2(2)^2 - 5 \cdot 2 + 3 \Rightarrow y_1 = 1$

$m = f'(x) \Rightarrow m = 4x - 5$ at $x = 2$

$m = 3$

$\underline{y - 1 = 3(x - 2)}$

or

$\underline{y = 3x - 5}$

Find the points where the graph has a horizontal tangent line:

$f(x) = x^3 - 6x^2 + 15$

$f'(x) = 0$

$f'(x) = 3x^2 - 12x$

$3x^2 - 12x = 0$

$3x(x - 4) = 0$

$\underline{x_1 = 0}$

$\underline{x_2 = 4}$

finding y:

$f(0) = 0^3 - 6 \cdot 0^2 + 15 = 15$

$P_1 = (0; 15)$

$f(4) = 4^3 - 6 \cdot 4^2 + 15 = 79$

$P_2 = (4; 79)$

Find the equation of the normal line

$y = x^3 - 4x^2 + 5$ at $x = 2$

1) find y coordinate at $x = 2$:

$y = 2^3 - 4(2)^2 + 5 \Rightarrow \underline{y = -3}$

2) slope of the tangent line:

2) slope of the [illegible]

$$y' = 3x^2 - 8x \qquad \text{at } x = 2 \qquad \underline{m = -4}$$

3) normal line: $P = (2, -3)$ $m_{tan} = -4$

$$m_n = +\frac{1}{4}$$

$$y - (-3) = \frac{1}{4}(x - 2)$$

$$\underline{y + 3 = \frac{1}{4}(x-2)}$$

or

$$\underline{y = \frac{1}{4}x - \frac{7}{2}}$$

Inverse trig. functions

$$\frac{d}{dx}\left(\sin^{-1}(u)\right) = \frac{u'}{\sqrt{1-u^2}} \qquad \frac{d}{dx}\left[\tan^{-1}(u)\right] = \frac{u'}{1+u^2}$$

$$\frac{d}{dx}\left[\cos^{-1}(u)\right] = -\frac{u'}{\sqrt{1-u^2}} \qquad \frac{d}{dx}\left[\sec^{-1}(u)\right] = \frac{u'}{|u|\sqrt{u^2-1}}$$

---

critical points: when
- $f'(x) = 0$
- $f'(x) = DNE$

Find local min/max of the function:

$$f(x) = 2x^3 + 3x^2 - 12x$$

$$f'(x) = 6x^2 + 6x - 12$$

critical points: $f'(x) = 0$

$6x^2+6x-12=0$

$(x-1)(x+2)=0$ → $x_1=1$, $x_2=-2$

		-2		1	
$f'(x)$	$+$		$-$		$+$
$f(x)$	↗	max	↘	min	↗

max: $(-2;20)$

min: $(1;-7)$

---

increasing $f(x) \Rightarrow f'(x)$ positive

decreasing $f(x) \Rightarrow f'(x)$ negative

Find the intervals where the function is increasing/decreasing

$f(x)=x^2-3x+1$

$f'(x)=2x-3$

$2x-3=0$

$x=3/2$

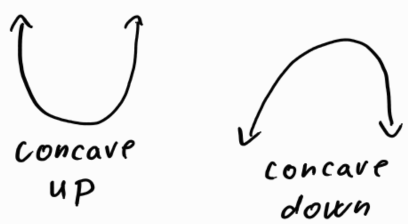
		$3/2$	
$f'(x)$	$-$		$+$
$f(x)$	↘	min	↗

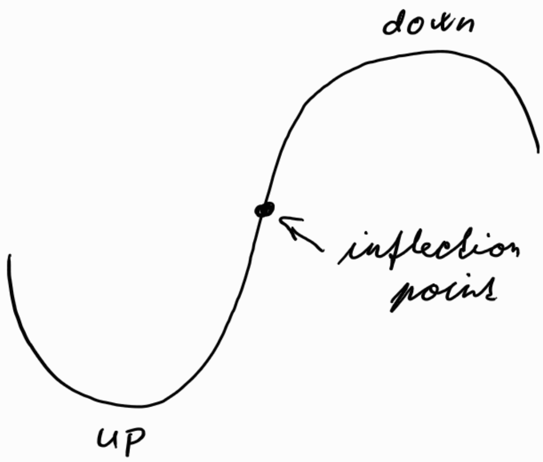
increasing: $(3/2;\infty)$

decreasing $(-\infty;3/2)$

---

concavity:





Find inflection points and where the fun. is concave up/down

$$f(x) = x^3 - 9x^2 + 7x$$

$$f'(x) = 3x^2 - 18x + 7$$

$$f'(x) = 6x - 18$$

$$0 = 6x - 18$$

$$0 = 6(x-3) \Rightarrow x = 3$$

inflection point

		3	
$f''(x)$	$-$	|	$+$
	down	↓	up
		infl. point	

concave down: $(-\infty; 3)$

concave up: $(3; \infty)$