

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

$$f'(x) = 2(x^2 + 3x)(x^2 + 3x)'(2x + 1) + (x^2 + 3x)^2 \cdot 2$$

$$2. f(x) = \frac{\sqrt{x+1}}{\sqrt{x^2+1}}$$

$$f'(x) = \frac{1}{2} \left(\frac{x+1}{x^2+1} \right)^{-1/2} \left(\frac{x+1}{x^2+1} \right)'$$

$$= \frac{1}{2} \left(\frac{x+1}{x^2+1} \right)^{-1/2} \cdot \left(\frac{(x^2+1) - (x+1)2x}{(x^2+1)^2} \right)$$

$$f'(1) = \frac{1}{2} \cdot \frac{-2}{4} = -\frac{1}{4}$$

$$3. \frac{dy}{dt} = \frac{dy}{dx} \cdot \frac{dx}{dt} = 2(f(x) + 3x)(f'(x) + 3)(3t^2 - 2)$$

$$\frac{dy}{dt} \Big|_{t=2} = 2 \cdot (f(4) + 12) \cdot (f'(4) + 3)(10) = 180$$

$$f'(4) = -\frac{5}{2}$$

$$4. 2x + 6xy + 3x^2 \cdot \frac{dy}{dx} + 3y^2 \cdot \frac{dy}{dx} = 0.$$

$$3(x^2 + y^2) \frac{dy}{dx} = -2x - 6xy$$

$$\frac{dy}{dx} = \frac{-2x - 6xy}{3(x^2 + y^2)} \Rightarrow \frac{dy}{dx} \Big|_{(0,1)} = 0.$$

$$2 + 6y + 6x \cdot \frac{dy}{dx} + 3x^2 \cdot \frac{d^2y}{dx^2} + 6y \frac{dy}{dx} + 3y^2 \cdot \frac{d^2y}{dx^2} = 0$$

$$\Rightarrow 8 + 3 \frac{dy^2}{dx^2} = 0 \Rightarrow \frac{d^2y}{dx^2} = -\frac{8}{3}$$

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

$$(1) f'(x) = 3x^2 - 6x = 3x(x-2)$$

$$f'(x) = 0 \Rightarrow x = 0, 2$$

$f(2) = -2$ is relative min.

$f(0) = 2$ is relative max.

x		0		2	
$f'(x)$	+	0	-	0	+
$f(x)$	↗	2	↘	-2	↗

(2) $f(4) = 18$ is abs max

$f(2) = -2$ is abs. min.

x	0		2		4
$f'(x)$		-	0	+	
$f(x)$	2	↘	-2	↗	18