Power Rule:
$$\frac{d}{dx}[x^n] = nx^{n-1}$$

Product Rule:
$$\frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + f(x)g'(x)$$

Constant Multiple Rule:
$$\frac{d}{dx}[cf(x)] = c\frac{d}{dx}[f(x)]$$

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

Sum & Difference:
$$\frac{d}{dx}[f(x) \pm g(x)] = f'(x) \pm g'(x)$$

Chain Rule:
$$\frac{d}{dx}[f(g(x))] = f'(g(x))g'(x)$$

Trig Functions:

$$\frac{d}{dx}[\sin x] = \cos x \qquad \frac{d}{dx}[\tan x] = \sec^2 x \qquad \frac{d}{dx}[\sec x] = \sec x \tan x$$
$$\frac{d}{dx}[\cos x] = -\sin x \qquad \frac{d}{dx}[\cot x] = -\csc^2 x \qquad \frac{d}{dx}[\csc x] = -\csc x \cot x$$

Exponential and Logarithmic Functions:

$$\frac{d}{dx}[a^x] = a^x \ln a \qquad \frac{d}{dx}[e^x] = e^x$$
$$\frac{d}{dx}[\log_a x] = \frac{1}{x \ln a} \qquad \frac{d}{dx}[\ln x] = \frac{1}{x}$$

<u>5.8-ish</u>

$$\frac{d}{dx}[\arcsin x] = \frac{1}{\sqrt{1-x^2}}$$
$$\frac{d}{dx}[\arctan x] = \frac{1}{1+x^2}$$
$$\frac{d}{dx}[\operatorname{arcsec} x] = \frac{1}{|x|\sqrt{x^2-1}}$$
$$\frac{d}{dx}[\arccos x] = \frac{-1}{\sqrt{1-x^2}}$$
$$\frac{d}{dx}[\operatorname{arccot} x] = \frac{-1}{1+x^2}$$
$$\frac{d}{dx}[\operatorname{arccsc} x] = \frac{-1}{|x|\sqrt{x^2-1}}$$

$f(x) = \arcsin(3x)$

$$f'(x) = \frac{1}{\sqrt{1-(3x)^2}} \cdot 3 = \frac{3}{\sqrt{1-9x^2}}$$

$f(x) = \arctan(\ln(2x))$

$$f'(x) = \frac{1}{1+[\ln(2x)]^2} \cdot \frac{1}{2x} \cdot 2$$

$$= \frac{1}{x\left(1+[\ln(2x)]^2\right)}$$

$$f(x) = \cot\left(5^{\arcsin(4x^3)}\right)$$

56. $y = x\arctan 2x - \frac{1}{4}\ln(1+4x^2)$

$$y' = 1\cdot\arctan 2x + x\cdot\frac{2}{1+(2x)^2} - \frac{1}{\cancel{4}}\cdot\frac{\overset{2}{\cancel{8}}x}{1+4x^2}$$

$4x^2$

$$= \arctan 2x + \frac{2x}{1+4x^2} - \frac{2x}{1+4x^2} = \boxed{\arctan 2x}$$

$$\frac{d}{dx}[\arcsin x] = \frac{1}{\sqrt{1-x^2}}$$
$$\frac{d}{dx}[\arctan x] = \frac{1}{1+x^2}$$
$$\frac{d}{dx}[\operatorname{arcsec} x] = \frac{1}{|x|\sqrt{x^2-1}}$$
$$\frac{d}{dx}[\arccos x] = \frac{-1}{\sqrt{1-x^2}}$$
$$\frac{d}{dx}[\operatorname{arccot} x] = \frac{-1}{1+x^2}$$
$$\frac{d}{dx}[\operatorname{arccsc} x] = \frac{-1}{|x|\sqrt{x^2-1}}$$

5.4 – Find the second derivative

80. $f(x) = \frac{1}{x-2} = (x-2)^{-1}$

$$f'(x) = -(x-2)^{-2}$$

$$f''(x) = 2(x-2)^{-3} = \boxed{\frac{2}{(x-2)^3}}$$

$$f(x) = x^3 + 2x^2 + x + 4$$
$$f'(x) = 3x^2 + 4x + 1$$
$$f''(x) = 6x + 4$$
$$f'''(x) = 6$$
$$f^{(4)}(x) = 0$$
$$f^{(5)}(x) = 0$$
$$f^{(89)}(x) = 0$$

$$f(x) = x^6 + 2x^5 + x^2 - x$$
$$f'(x) = 6x^5 + 10x^4 + 2x - 1$$
$$f''(x) = 30x^4 + 40x^3 + 2$$
$$f'''(x) = 120x^3 + 120x^2$$
$$f^{(4)}(x) = 360x^2 + 240x$$
$$f^{(5)}(x) = 720x + 240$$
$$f^{(6)}(x) = 720$$
$$f^{(7)}(x) = 0$$
$$f^{(8)}(x) = 0$$

The $(n+1)^{st}$ derivative of an n^{th} degree polynomial is 0.

The n^{th} derivative is $c \cdot n!$ where c is the leading coefficient.

$$f(x) = 9x^{15} + 4x^9 - 29000x^2 + \pi$$

$$f^{(18)}(x) = 0$$

$$f^{(15)}(x) = 9 \cdot 15 \cdot 14 \cdot 13 \cdot 12 \cdot 11 \cdot 10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2$$

$$f(x) = \sqrt[3]{\sin^2(\ln(4x^9))} = \left[\left(\sin\left[\ln(4x^9)\right]\right)^2\right]^{1/3}$$

$$(x^m)^n = x^{mn}$$

$$= \left(\sin\left[\ln(4x^9)\right]\right)^{2/3}$$

$$f'(x) = \frac{2}{3}(\quad)^{-1/3} \cdot \cos(\quad) \cdot \frac{1}{(\quad)} \cdot 36x^8$$