Higher-Order Derivatives

→ can be defined as any derivative beyond first derivative

- 2nd derivative → $f''(x)$, $\frac{d^2y}{dx^2}$, $\frac{d^2}{dx^2}[f(x)]$, y''
- 3rd derivative → $f'''(x)$, $\frac{d^3y}{dx^3}$, $\frac{d^3}{dx^3}[f(x)]$, y'''
- nth derivative → $f^{(n)}(x)$, $y^{(n)}$

<u>EX</u> → $y = 5x^4 - 4x^3 + 3x - 7$

$y' = 20x^3 - 12x^2 + 3$

$y'' = 60x^2 - 24x$

$y''' = 120x - 24$

$y^{(4)} = 120$

$y^{(5)} = 0$

- Derivatives of Trig Functions
  - $\rightarrow \dfrac{d}{dx}\left[\sin x\right] = \cos x$
  - $\rightarrow \dfrac{d}{dx}\left[\cos x\right] = -\sin x$
- We can derive derivatives for other trig functions
  - $\rightarrow \dfrac{d}{dx}\left[\tan x\right] = \dfrac{d}{dx}\left[\dfrac{\sin x}{\cos x}\right] = \dfrac{(\cos x)(\cos x) - (\sin x)(-\sin x)}{\cos^2 x} = \dfrac{\cos^2 x + \sin^2 x}{\cos^2 x} = \dfrac{1}{\cos^2 x} = \boxed{\sec^2 x}$
  - $\rightarrow \dfrac{d}{dx}\left[\cot x\right] = \dfrac{d}{dx}\left[\dfrac{\cos x}{\sin x}\right] = \dfrac{(\sin x)(-\sin x) - (\cos x)(\cos x)}{\sin^2 x} = \dfrac{-\sin^2 x - \cos^2 x}{\sin^2 x} = \dfrac{-1(\sin^2 x + \cos^2 x)}{\sin^2 x} = \boxed{-\csc^2 x}$
  - $\rightarrow \dfrac{d}{dx}\left[\sec x\right] = \dfrac{d}{dx}\left[\dfrac{1}{\cos x}\right] = \dfrac{\cancelto{0}{(\cos x)(0)} - (1)(-\sin x)}{\cos^2 x} = \dfrac{\sin x}{\cos^2 x} = \dfrac{\sin x}{\cos x} \cdot \dfrac{1}{\cos x} = \boxed{\tan x \sec x}$
  - $\rightarrow \dfrac{d}{dx}\left[\csc x\right] = \dfrac{d}{dx}\left[\dfrac{1}{\sin x}\right] = \dfrac{\cancel{(\sin x)}(0) - (1)(\cos x)}{\sin^2 x} = \dfrac{-\cos x}{\sin^2 x} = \dfrac{-\cos x}{\sin x} \cdot \dfrac{1}{\sin x} = \boxed{-\cot x \csc x}$

HW: p. 115 → 19-24, 51, 52

p. 126 → 5, 6, 11, 12, 26-38 even