

# Advanced Derivative Rules

## 4.2 A – Chain Rule & Trigonometry

$$\begin{aligned}
 \#1) \quad \frac{d}{dx}[\cos^3(x)] &= \frac{d}{dx}[\cos(x)]^3 \\
 &= 3[\cos(x)]^2 \cdot [\cos(x)]' \\
 &= 3\cos^2(x) \cdot (-\sin(x)) \cdot x' \\
 &= -3\cos^2(x)\sin(x) \cdot (1) \\
 \frac{d}{dx}[\cos^3(x)] &= -3\cos^2(x)\sin(x)
 \end{aligned}$$

$$\begin{aligned}
 \#2) \quad \frac{d}{dx}[\tan^4(x)] &= \frac{d}{dx}[\tan(x)]^4 \\
 &= 4[\tan(x)]^3 \cdot \frac{d}{dx}\tan(x) \\
 &= 4\tan^3(x) \cdot \sec^2(x) \cdot x' \\
 &= 4\tan^3(x)\sec^2(x) \cdot (1) \\
 \frac{d}{dx}[\tan^4(x)] &= 4\tan^3(x)\sec^2(x)
 \end{aligned}$$

$$\begin{aligned}
 \#3) \quad \frac{d}{dx}[\cos(x^3)] &= -\sin(x^3) \cdot \frac{d}{dx}(x^3) \\
 &= -\sin(x^3) \cdot 3x^2 \\
 \frac{d}{dx}[\cos(x^3)] &= -3x^2\sin(x^3)
 \end{aligned}$$

$$\begin{aligned}
 \#4) \quad \frac{d}{dx}[\cot(x^5)] &= -\csc^2(x^5) \cdot (x^5)' \\
 &= -\csc^2(x^5) \cdot 5x^4 \\
 \frac{d}{dx}[\cot(x^5)] &= -5x^4\csc^2(x^5)
 \end{aligned}$$

$$\begin{aligned}
 \#5) \quad \frac{d}{dx}[\csc^3(x)] &= \frac{d}{dx}[\csc(x)]^3 \\
 &= 3[\csc(x)]^2 \cdot \frac{d}{dx}\csc(x) \\
 &= 3\csc^2(x) \cdot (-\csc(x)\cot(x)) \\
 \frac{d}{dx}[\csc^3(x)] &= -3\csc^3(x)\cot(x)
 \end{aligned}$$

$$\begin{aligned}
 \#6) \quad \frac{d}{dx}[\sec^4(x)] &= \frac{d}{dx}[\sec(x)]^4 \\
 &= 4[\sec(x)]^3 \cdot \frac{d}{dx}[\sec(x)] \\
 &= 4\sec^3(x) \cdot \sec(x)\tan(x) \\
 \frac{d}{dx}[\sec^4(x)] &= 4\sec^4(x)\tan(x)
 \end{aligned}$$

$$\begin{aligned}
 \#7) \quad \frac{d}{dx}[\sin(x^3)] &= \cos(x^3) \cdot (x^3)' \\
 &= \cos(x^3) \cdot 3x^2 \\
 \frac{d}{dx}[\sin(x^3)] &= 3x^2\cos(x^3)
 \end{aligned}$$

$$\begin{aligned}
 \#8) \quad \frac{d}{dx}[\cos(8x)] &= -\sin(8x) \cdot (8x)' \\
 &= -\sin(8x) \cdot 8 \\
 \frac{d}{dx}[\cos(8x)] &= -8\sin(8x)
 \end{aligned}$$