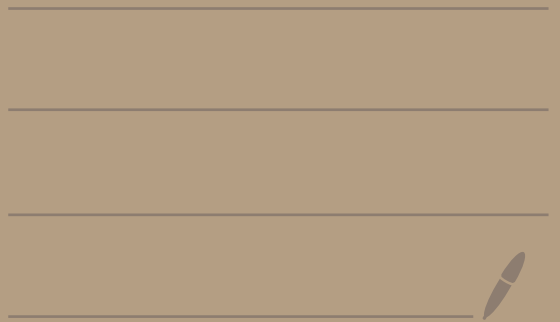


Math 2150-01  
1/22/25



# Topic 0 - Calculus Review

$$\frac{d}{dx} x^n = n x^{n-1}$$

$$\frac{d}{dx} x^7 = 7x^6$$

$$\frac{d}{dx} \sin(x) = \cos(x)$$

$$\frac{d}{dx} \cos(x) = -\sin(x)$$

$$\frac{d}{dx} \ln(x) = \frac{1}{x}$$

$$\frac{d}{dx} e^x = e^x$$

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C$$

$n \neq -1$

$\int x^3 dx = \frac{1}{4}x^4 + C$

$$\int \frac{1}{x} dx = \ln |x| + C$$

$$\int \sin(x) dx = -\cos(x) + C$$

$$\int \cos(x) dx = \sin(x) + C$$

$$\int e^x dx = e^x + C$$

# Chain rule

$$(f(g(x)))' = f'(g(x)) \cdot g'(x)$$

↑                      ↑  
outer                  inner

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Ex:

$$\begin{aligned} & (\cos(x^3 + 2x))' \\ &= -\sin(x^3 + 2x) \cdot (3x^2 + 2) \\ &= (-3x^2 - 2) \sin(x^3 + 2x) \end{aligned}$$

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# product rule

$$(fg)' = f'g + fg'$$

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Ex:

$$\left( \underbrace{5x^7}_f \underbrace{\sin(x)}_g \right)'$$

$$= \underbrace{35x^6 \sin(x)}_{f'g} + \underbrace{5x^7 \cos(x)}_{fg'}$$

# Substitution

$$\int \underbrace{g(h(x))}_u \cdot \underbrace{h'(x)dx}_{du} = \int g(u) du$$

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Ex:

$$\int 5 \sin(5x) dx$$

$$\begin{aligned} &= \int \sin(u) du = -\cos(u) + C \\ &= -\cos(5x) + C \end{aligned}$$

$$\begin{aligned} u &= 5x \\ du &= 5 dx \end{aligned}$$

Ex:  $\int \cos(\underbrace{10x}_u) dx$

$$\equiv \int \cos(u) \cdot \frac{1}{10} du$$

$\uparrow$

$$\begin{aligned} u &= 10x \\ du &= 10 dx \\ \frac{1}{10} du &= dx \end{aligned}$$

$$= \frac{1}{10} \sin(u) + C$$

$$= \frac{1}{10} \sin(10x) + C$$

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Ex:  $\int e^{15x} dx$

$$\equiv \frac{1}{15} e^{15x} + C$$

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Ex:

$$\int \frac{1}{x(\ln(x))^2} dx$$

$$= \int \frac{1}{(\ln(x))^2} \cdot \underbrace{\frac{1}{x} dx}_{du}$$

$$= \int \frac{1}{u^2} du = \int u^{-2} du$$

↑

$$u = \ln(x)$$
$$du = \frac{1}{x} dx$$

$$= \frac{u^{-1}}{-1} + C$$

$$= -\frac{1}{u} + C = -\frac{1}{\ln(x)} + C$$



# Integration by parts

$$\int u dv = uv - \int v du$$

How to pick u:



pick u as first in list

→

Ex:

$$\int \overbrace{x}^u \overbrace{e^x dx}^{dv}$$

algebraic

exponential

u

$$= x e^x - \int e^x dx$$

$$= x e^x - e^x + C$$

$$u = x \quad dv = e^x dx$$

$$du = dx \quad v = e^x$$

$$\int u dv = uv - \int v du$$