



**MATH 211**

**Calculus II Integral Calculus**

Module 1 Integration

Topic 6: The Substitution Method

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# Running the Chain Rule Backward

The Chain Rule:  $\frac{d}{dx} f(u) = f'(u) \cdot \frac{du}{dx}$

**Example.**  $\frac{d}{dx} (\sin(5x)) = \cos(5x) \cdot 5$

$$\frac{d}{dx} (e^{-x^2}) = e^{-x^2} \cdot (-2x)$$

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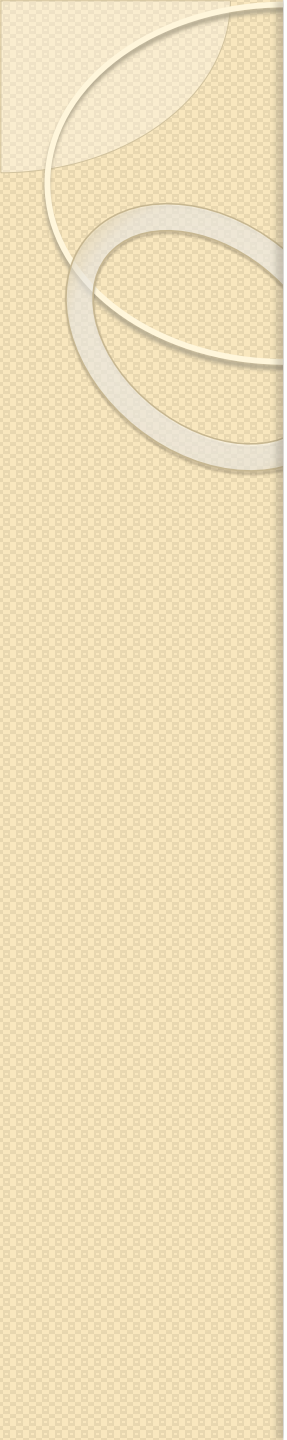
**Example.**  $\frac{d}{dx} (\sin(5x)) = \cos(5x) \cdot 5$   
 $\frac{d}{dx} (e^{-x^2}) = e^{-x^2} \cdot (-2x)$

**Question.** Can you evaluate these?

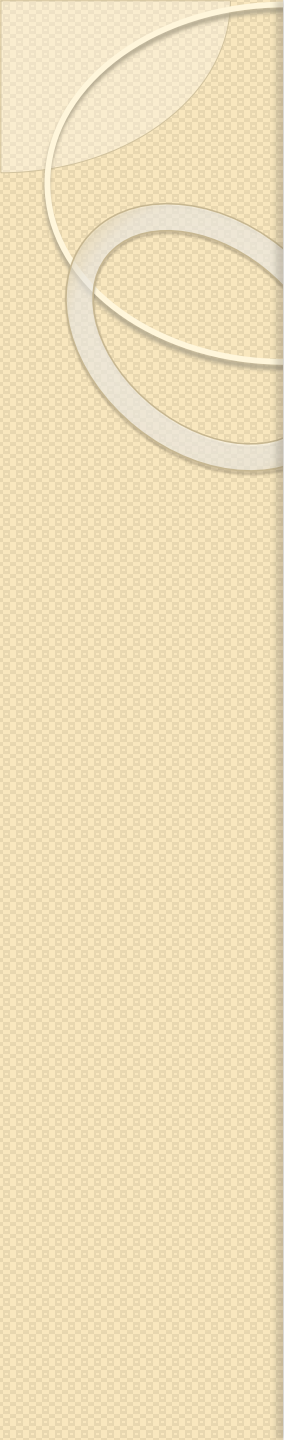
(a)  $\int 5 \cos 5x \, dx$       (b)  $\int -2x e^{-x^2} \, dx$

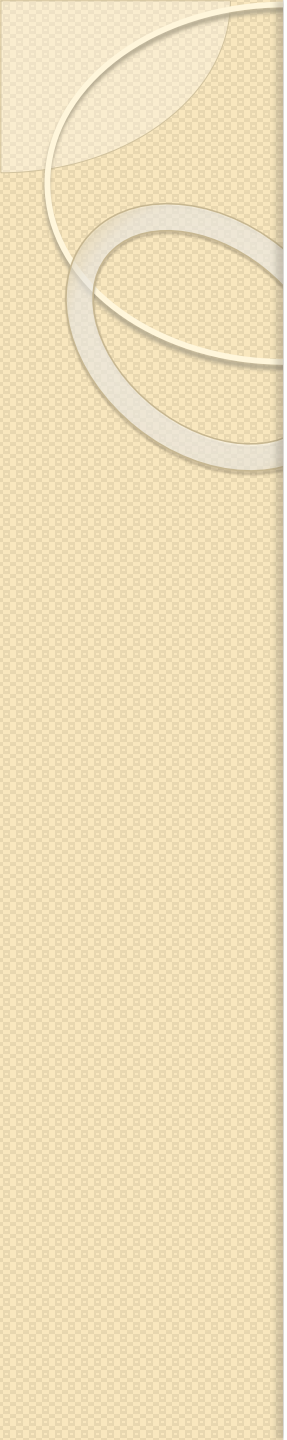
# Substitution Rule: Procedure and Notation

Evaluate: (a)  $\int \sqrt{2x + 1} dx$



(b)  $\int \cos(7\theta + 3) d\theta$


$$(c) \int \frac{2x dx}{\sqrt[3]{x^2+1}}$$



(d)  $\int x\sqrt{2x+1} dx$


$$(e) \int \sin^2 x \, dx$$



# Challenge Problem

Evaluate  $\int \cot x \, dx$ .

(Hint: Consider  $\cot x = \frac{\cos x}{\sin x}$  and substitute  $u = \sin x$ .)