

Integration by Substitutions (4A)

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Chain Rule

$$f(g(x)) \xrightarrow{\frac{d}{dx}} f'(g(x)) \cdot g'(x)$$

$$\frac{df}{dx} = \frac{df}{dg} \cdot \frac{dg}{dx}$$

$$\frac{df}{dg} = f'(g)$$

$$\frac{dg}{dx} = g'(x)$$

$$f(\boxed{}) \xrightarrow{\frac{d}{dx}} f'(\boxed{}) \cdot \boxed{}$$

Substitution Rule

$$f(g(x)) + C \longleftarrow \int \cdot dx \longleftarrow f'(g(x)) \cdot g'(x)$$

$$f(g(x)) + C = \int f'(g(x)) \cdot g'(x) dx$$

$$f(u) + C = \int f'(u) \cdot du$$

$$\begin{aligned} \int f'(g(x)) \cdot g'(x) dx &= \int f'(g(x)) \cdot \frac{dg}{dx} dx \\ &= \int f'(u) du \\ &= f(u) + C \end{aligned}$$

$$u = g(x)$$

$$du = \frac{dg}{dx} dx$$

Chain Rule and Substitution Rule

$$f(g(x)) \xrightarrow{\frac{d}{dx}} f'(g(x)) \cdot g'(x)$$
$$\frac{df}{dx} = \frac{df}{dg} \cdot \frac{dg}{dx}$$

$$f(g(x)) + C \xleftarrow{\int \cdot dx} f'(g(x)) \cdot g'(x)$$
$$f(g(x)) + C = \int f'(g(x)) \cdot g'(x) dx$$

Substitution Rule

$$f(g(x)) + C \longleftarrow \int \cdot dx \longleftarrow f'(g(x)) \cdot g'(x)$$

$$f(g(x)) + C = \int f'(g(x)) \cdot g'(x) dx$$

$$f(x) + C = \int f'(x) dx$$

$$F(g(x)) + C \longleftarrow \int \cdot dx \longleftarrow f(g(x)) \cdot g'(x)$$

$$F(g(x)) + C = \int f(g(x)) \cdot g'(x) dx$$

$$F(x) + C = \int f(x) dx$$

References

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- [3] E. Kreyszig, "Advanced Engineering Mathematics"
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