Calculus

Differentiability

- LHD $\implies \lim_{h\to o^-} \frac{f(c+h)-f(c)}{h}$
- RHD $\implies \lim_{h\to o^+} \frac{f(c+h)-f(c)}{h}$
- Derivative $\implies \lim_{h\to o} \frac{f(c+h)-f(c)}{h}$

Formulae

- $$\frac{d}{dx}(k) = 0$$
- $$\frac{d}{dx}(x) = 1$$
- $$\frac{d}{dx}(u \pm v) = \frac{d}{dx}(u) \pm \frac{d}{dx}(v)$$
- $$\frac{d}{dx}[f(x)]^n = n \cdot [f(x)]^{n-1} \cdot f'(x)$$
- $$\frac{d}{dx}[k \cdot f(x)] = k \cdot \frac{d}{dx} f(x)$$
- $$\frac{d}{dx}(u \cdot v) = u \cdot \frac{dv}{dx} + v \cdot \frac{du}{dx}$$
- $$\frac{d}{dx}(\frac{u}{v}) = \frac{v \cdot \frac{du}{dx} - u \cdot \frac{dv}{dx}}{v^2}$$
- $$\frac{d}{dx} e^{f(x)} = e^{f(x)} \cdot f'(x)$$
- $$\frac{d}{dx} a^{f(x)} = a^{f(x)} \cdot f'(x) \cdot \ln a$$
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$$\frac{d}{dx}\ln f(x) = \frac{1}{f(x)} \cdot f'(x)$$

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

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

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$$\frac{d}{dx}\tan f(x) = \sec^2 f(x) \cdot f'(x)$$

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$$\frac{d}{dx}\cot f(x) = -\csc^2 f(x) \cdot f'(x)$$

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$$\frac{d}{dx}\sec f(x) = \sec f(x) \cdot \tan f(x) \cdot f'(x)$$

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$$\frac{d}{dx}\csc f(x) = -\csc f(x) \cdot \cot f(x) \cdot f'(x)$$

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$$\frac{d}{dx}\sin^{-1} x = \frac{1}{\sqrt{1-x^2}} \cdot f'(x)$$

Integration

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$$\int f(x)^n dx = \frac{f(x)^{n+1}}{(n+1)f'(x)} + C$$

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$$\int dx = x + C$$

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$$\int k \cdot dx = kx + C$$

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$$\int\ cos f(x) dx = \frac{sin\, f(x)}{f'(x)} + C$$

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- $\int\, sin f(x) dx = -\frac{cos\, f(x)}{f'(x)} + C$

- $\int\, \sec^2 f(x) dx = \frac{tan\, f(x)}{f'(x)} + C$

- $\int\, \csc^2 f(x) dx = -\frac{cot\, f(x)}{f'(x)} + C$

- $\int\, sec f(x) \cdot tan f(x) dx = \frac{sec\, f(x)}{f'(x)} + C$

- $\int\, csc f(x) \cdot cot f(x) dx = -\frac{csc\, f(x)}{f'(x)} + C$

- $\int\, \frac{1}{\sqrt{1-x^2}} dx = sin^{-1} x + C$

- $-\int\, \frac{1}{\sqrt{1-x^2}} dx = cos^{-1} x + C$

- $\int\, \frac{1}{1+x^2} dx = tan^{-1} x + C$

- $-\int\, \frac{1}{1+x^2} dx = cot^{-1} x + C$

- $\int\, \frac{1}{x\sqrt{x^2-1}} dx = \sec^{-1} x + C$

- $-\int\, \frac{1}{x\sqrt{x^2-1}} dx = \csc^{-1} x + C$

- $\int e^{f(x)} dx = e^{f(x)} + C$

- $\int \frac{1}{f(x)} dx = \frac{\ln|f(x)|}{f'(x)} + C$

- $\int a^{f(x)} dx = \frac{a^{f(x)}}{f'(x) \cdot \log a} + C$

- $\int f(x)^n \cdot f'(x) dx = \frac{f(x)^{n+1}}{(n+1) f'(x)} + C$

- $\int \frac{f'(x)}{f(x)} dx = \ln|f(x)| + C$

- $\int linear\sqrt{linear} \implies \textbf{Put } \sqrt{linear} = t$

- $\int \tan f(x) dx = \frac{\log|\sec f(x)|}{f'(x)} + C = \frac{-\log|\csc f(x)|}{f'(x)} + C$

- $\int \cot f(x) dx = \frac{\log|\csc f(x)|}{f'(x)} + C$

- $\int \sec f(x) dx = \frac{\log|\sec f(x) + tan f(x)|}{f'(x)} + C$

- $\int \csc f(x) dx = \frac{\log|\csc f(x) + cot f(x)|}{f'(x)} + C$

- $\int \frac{1}{x^2 - a^2} dx = \frac{1}{2a} \cdot \ln|\frac{x-a}{x+a}| + C$

- $\int \frac{1}{a^2 + x^2} dx = \frac{1}{2a} \cdot \ln|\frac{a+x}{a-x}| + C$

- $\int \frac{1}{\sqrt{x^2 - a^2}} dx = \log|x + \sqrt{x^2 - a^2}| + C$

$$\int \frac{1}{\sqrt{a^2-x^2}} dx = \sin^{-1} \frac{x}{a} + C$$

- $$\int \frac{1}{\sqrt{x^2+a^2}} dx = \log |x + \sqrt{x^2 + a^2}| + C$$

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