

MAT 210. BRIEF CALCULUS

Rules for finding derivatives

- **Derivative of a constant.** For any constant C ,

$$\frac{d}{dx}[C] = 0.$$

- **Derivative of a constant times a function.** For any constant C and differentiable function $f(x)$,

$$\frac{d}{dx}[Cf(x)] = C \frac{d}{dx}[f(x)].$$

- **Sum rule.** For differentiable functions $f(x)$ and $g(x)$,

$$\frac{d}{dx}[f(x) + g(x)] = \frac{d}{dx}[f(x)] + \frac{d}{dx}[g(x)].$$

- **Product rule.** For differentiable functions $f(x)$ and $g(x)$,

$$\frac{d}{dx}[f(x) \cdot g(x)] = f(x) \cdot \frac{d}{dx}[g(x)] + g(x) \cdot \frac{d}{dx}[f(x)].$$

- **Quotient rule.** For differentiable functions $f(x)$ and $g(x)$,

$$\frac{d}{dx} \left[\frac{f(x)}{g(x)} \right] = \frac{f'(x)g(x) - g'(x)f(x)}{[g(x)]^2},$$

provided $g(x) \neq 0$.

- **Chain rule.** For differentiable functions $y = f(u)$ and $u = g(x)$,

$$\frac{d}{dx}[f(g(x))] = f'(g(x)) \cdot g'(x),$$

or

$$\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}.$$

- **Power rule.** For any real number n ,

$$\frac{d}{dx}[x^n] = nx^{n-1}.$$

- **General power rule.** For any real number n and differentiable function $f(x)$,

$$\frac{d}{dx}[(f(x))^n] = n(f(x))^{n-1} f'(x).$$

- **Exponent rule (1).**

$$\frac{d}{dx}[e^x] = e^x.$$

- **Exponent rule (2).** For $f(x)$ which is differentiable,

$$\frac{d}{dx}[e^{f(x)}] = e^{f(x)} f'(x).$$

- **General exponent rule.** For constant a and $f(x)$ which is differentiable,

$$\frac{d}{dx}[a^{f(x)}] = e^{f(x)} f'(x) \ln a.$$

- **Logarithm rule (1).** For $x > 0$,

$$\frac{d}{dx}[\ln x] = \frac{1}{x}.$$

- **Logarithm rule (2).** For any differentiable function $f(x)$ such that $f(x) > 0$,

$$\frac{d}{dx}[\ln f(x)] = \frac{f'(x)}{f(x)}.$$

- **Logarithm rule (3).** For any differentiable function $f(x)$ such that $f(x) \neq 0$,

$$\frac{d}{dx}[\ln |f(x)|] = \frac{f'(x)}{f(x)}.$$

- **Derivatives of $\sin x$ and $\cos x$.**

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

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