

THE CHAIN RULE

Math 1110 - Instructor: Itamar Oliveira

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1 STATEMENT AND EXAMPLES

Theorem 1 (Chain rule). *If $f(u)$ is differentiable at the point $u = g(x)$ and $g(x)$ is differentiable at x , then the composite function $(f \circ g)(x) = f(g(x))$ is differentiable at x , and*

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

In Leibniz's notation, if $y = f(u)$ and $u = g(x)$, then

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

where dy/du is evaluated at $u = g(x)$.

1. An object moves along the x -axis so that its position at any time $t \geq 0$ is given by $x(t) = \cos(t^2 + 1)$. Find the velocity of the object as a function of t .

2. Evaluate

$$\lim_{x \rightarrow 0} \frac{\sin[(3+x)^2] - \sin 9}{x}.$$

3. Find the derivative of

$$f(\theta) = \sin\left(\theta + \sqrt{\theta + 1}\right).$$

4. Differentiate

$$y = \frac{3}{(5x^2 + \sin 2x)^{\frac{3}{2}}}.$$

5. Find f' for

$$f(x) = \frac{1}{\sin(x - \sin x)}.$$