Homework 04

Math 140-002: Calculus I (Spring 2026)
Week 4

Relevant topics: tangent and secant lines; limit definition of the derivative; basic derivative rules (sum/difference, constant multiple, power); product and quotient rules; derivatives of trigonometric functions; higher-order derivatives
Due: Wednesday, Feb 11, 2026.
Instructions: Show your work clearly. Problems 1–6 emphasize computational fluency; Problems 7–12 emphasize concepts and communication.

1. Evaluate $\dfrac{d}{dx}\left(5x^6 - 2x^4 + 7x - 9\right)$.
2. Evaluate $\dfrac{d}{dx}\left(3\sin(x) - 2\cos(x) + x^2\right)$.
3. Evaluate $\dfrac{d}{dx}\left((2x-5)(x^2+1)\right)$.
4. Evaluate $\dfrac{d}{dx}\left(\dfrac{x^2 - 3x + 1}{x - 2}\right)$.
5. Evaluate $\dfrac{d}{dx}\left(\dfrac{\sin(x)}{x^2 + 4}\right)$.
6. Let $f(x) = x^3 - 6x$. Compute $f''(x)$.
7. Let $f(x) = x^3$.
   (a) Find the slope of the secant line to $y = f(x)$ on $[1, 1+h]$ (assume $h \neq 0$).
   (b) Compute $\lim_{h \to 0}$ of your answer from part (a) and interpret the result.
8. Use the limit definition to compute $f'(0)$ if $f(x) = \sqrt{x+1}$. (Your final answer should be a number.)
9. Consider $f(x) = |x - 2|$.
   (a) Show that f is continuous at $x = 2$.
   (b) Compute the one-sided derivatives $f'(2^-)$ and $f'(2^+)$ using the definition of the derivative. Conclude that f is not differentiable at $x = 2$.
10. Find the equation of the tangent line to $y = \cos(x)$ at $x = \pi/3$. (Your final answer should be in point-slope or slope-intercept form.)
11. Let $g(x) = x^4 - 4x^2$.
    (a) Compute $g'(x)$ and $g''(x)$.
    (b) Find all x where the tangent line to $y = g(x)$ is horizontal.
    (c) Determine where g is concave up and concave down.
12. Use a tangent line (linear approximation) to estimate $\sqrt{16.4}$. Then state whether your estimate is an overestimate or an underestimate, and briefly justify your answer.