• Your exam should contain 5 problems on 4 pages. Check that you have a complete exam!
• Unless otherwise instructed, show all your work. Answers with no supporting work, or obtained by guess-and-check, will result in little or no credit, even if correct.
• Indicate your final answer by placing a box around it.
• Unless otherwise indicated, leave your answers in exact form instead of a decimal approximation. That is, $\sqrt{2}$ instead of 1.4142, and $\frac{\pi}{2}$ instead of 1.57. Simplify all you can.
• If you need more room, use the backs of pages, but indicate to the grader that you have done so.
• Raise your hand if you have any questions.

GOOD LUCK!

Do you want your grades so far posted on our class website, in about 1 week, by last 4 digits of your student ID?

☐ Yes, please post my grade. Sign to give permission: ____________________________

☐ No, please don’t post my grades.
(13 points) Compute the derivatives of the following functions. No need to simplify your answers.

a) \( f(t) = (t^2 + 5) \arctan(3t) \)

b) \( g(x) = \ln(x - \sqrt{1 + x^2}) \)

c) \( y = \left(\frac{1}{x}\right)^{\sec x} \)
2 (12 points) Consider the spiral curve given by the following parametric equations, with $0 \leq t \leq 3$:

$$
\begin{align*}
  x(t) &= t \cos(\pi t) \\
  y(t) &= t \sin(\pi t)
\end{align*}
$$

a) Compute the horizontal and vertical velocities (as functions of t).

b) Compute the equation of the tangent line to this curve at the point corresponding to $t = 1$.

c) Find all times $t$, $0 \leq t \leq 3$, at which the curve crosses the y-axis.
3 (10 points) A boat is pulled towards a dock by a rope attached to the bow of the boat and passing through a pulley on the dock that is 2 m higher than the bow of the boat. If the rope is pulled in at a rate of 1.5 m/sec, how fast is the boat approaching the dock when it is 6 m from the dock?
4 (7 points) Let \( f(x) = (1 + x)^n \), where \( n \) is a constant.

a) Compute the linearization of \( f(x) \) at \( x = 0 \). Your answer will depend on \( n \).

b) Use the linearization you found in part (a) to approximate \( \sqrt[3]{1.009} \). Show all work, not just the final answer.

5 (8 points) Consider the cardioid curve given by the equation:
\[ x^2 + y^2 = (2x^2 + 2y^2 - x)^2 \]
Find the equation of the tangent line to this curve at the point \( (0, -\frac{1}{2}) \).