Problem 1. (12 points)
Given the function \( f(x) = x^6 + 3x^4 + 12x^2 - 3x + 9 \), find \( \frac{d^3 f}{dx^3}(1) \).

Problem 2. (15 points)
a) (7 points) State the definition of the derivative of a function \( f(x) \).
b) (8 points) Using the definition in part a), calculate \( \frac{d}{dx} (\sqrt{3x} + 1) \).

Problem 3. (12 points)
a) (6 points) The conclusion of the Chain Rule states that \( [f(g(x))]' = f'(g(x))g'(x) \), state the hypotheses necessary for this statement to make sense.

Problem 4. (24 points)
Calculate the following derivatives.
a) (8 points) \( \frac{d}{ds} \left[ \tan^{-1} s \right] \).
b) (8 points) \( \frac{d}{dx} \left[ \frac{e^x}{x^2 + 1} \right] \).
c) (8 points) \( \frac{d}{dt} \left[ \ln(t \sec t) \right] \).

Problem 5. (9 points)
Find a quadratic polynomial \( f(x) \) with \( f(0) = -2 \), \( f'(0) = 2 \) and \( f''(0) = 3 \).

Problem 6. (8 points)
Using Logarithmic Differentiation, find the derivative of \( f(x) = x \sin x \).

Problem 7. (5 points)
What is \( \frac{d}{dx} (\sin x) \)?
Problem 8. (15 points)
The Folium of Descartes is a curve defined by the equation

\[ x^3 + y^3 = 3xy. \]

Use Implicit Differentiation to find an expression for \( \frac{dy}{dx} \).