1. Find the derivatives.

(a) (5 pts)

\[ f(x) = \sec x + \ln x \]

(b) (5 pts) Find \( \frac{dy}{dx} \).

\[ y = \frac{x^2 + x}{x - 4} \]

(c) (5 pts) Find \( \frac{dy}{dx} \).

\[ e^y \sin x = 1 + \cos y \]

(d) (5 pts)

\[ g(s) = \log_2(1 - 3s) \]
2. (a) (5 pts) Using the known derivatives of $\sin x$ and $\cos x$, show that
\[ \frac{d}{dx} (\tan x) = \sec^2 x \]

(b) (10 pts) Show that
\[ \frac{d}{dx} \left( \arctan x \right) = \frac{1}{1 + x^2} \]
*Hint: Use implicit differentiation. And you will need to use a trigonometric identity to simplify the result.*

3. (10 pts) Find the equation of the line tangent to the curve:
\[ y = \sin(\sin(x)), \quad (\pi, 0) \]
4. (a) (5 pts) Find the critical numbers of the function \( s(t) = t^4 - 2t^2 + 2 \).

(b) (5 pts) Find the locations and values of the absolute maximum and minimum of the same function, \( s(t) = t^4 - 2t^2 + 2 \), on the interval \([-1, 2]\). You may use the information from (a).

5. (10 pts) If a snowball melts so that its surface area decreases at a rate of 1 cm\(^2\)/min, find the rate at which the diameter decreases when the diameter is 8 cm.
6. The half-life of cesium-137 is 30 years. Suppose we have a 1000-mg sample.
(a) (5 pts) Find the mass that remains after $t$ years.

(b) (5 pts) After how long would will only 1 mg remain? (There is no need to simplify your expression as long as it is correct.)

7. (10 pts) Sketch the graph of a function $f$ that is continuous on the interval $[1, 5]$, has no local minimum or local maximum, but for which 2 and 4 are critical numbers.
8. (a) (5 pts) Compute the linearization (linear approximation) $L(x)$ of the function $f(x) = e^x$ at the point $a = 0$.

(b) (5 pts) Use the linearization to approximate $e^{0.03}$.

(c) (5 pts) Graph the function $y = f(x)$ and its linearization $y = L(x)$ on the same axes. Give a scale on each axis, and label which graph is which.

**Extra Credit.** (3 pts) Show using Rolle’s theorem that a polynomial of degree 3 has at most three real roots.