1. (a) (16 pts) Evaluate the following limits.
   
   i. \( \lim_{x \to \pi} \frac{3\sin(x) - 1}{x - \pi} \)
   
   ii. \( \lim_{x \to \infty} \frac{\sinh(x)}{e^x} \)

   (b) (16 pts) Consider \( f(x) = e^{1/x} \).
   
   i. Find the domain of the function. Express your answer in interval notation.
   
   ii. Evaluate \( \lim_{x \to 0^-} f(x) \) and \( \lim_{x \to 0^+} f(x) \).
   
   iii. Find the horizontal asymptotes of \( f \), if any. Justify using appropriate limits.

2. (30 pts) The following problems are not related.
   
   (a) The curve given by the equation \( x^3 + y^3 = 6xy \) is called the folium of Descartes. Find an equation of the tangent line to the folium of Descartes at the point \((3, 3)\). Write your answer in the form \( y = mx + b \).
   
   (b) Let \( g(x) = \int_{4/x}^{1} t \cot(t) \, dt \). Find \( \frac{dg}{dx} \).
   
   (c) Given \( y = (\ln x)^{\cos x} \), find \( y' \) at \( x = \pi \). Simplify your answer.

3. (12 pts) Two particles are moving along a line. Particle A’s position is given by \( A(t) = t^2 + 2 + 3 \sin^2(t) \). Particle B’s position is given by \( B(t) = t - 3 \cos^2(t) \). At what time are A and B closest?

4. (18 pts) The following problems are not related.
   
   (a) The sum \( S = 11 + 13 + 15 + \cdots + 99 \) of odd integers can be written as \( \sum_{i=1}^{n} a_i \). Find the value of \( n \) and an expression for \( a_i \).
   
   (b) Approximate the value of \( \int_{0}^{1} \cos^{-1}(x) \, dx \) using \( L_2 \), the left-endpoint rectangle approximation with two equal subintervals. Simplify your answer.
   
   (c) Suppose \( f \) is a twice-differentiable function and the linearization of \( y = x^2 - f(x) \) at \( x = 5 \) is used to approximate values of \( y \) near \( x = 5 \). Given that \( f''(5) = -1 \), will the approximations be underestimates or overestimates? Explain.

TURN OVER—More problems on the back!
5. (24 pts) Evaluate the following integrals.

(a) \( \int_{0}^{10} h(x) \, dx \) given \( h(x) = \begin{cases} |x - 2| & \text{if } x \leq 6 \\ 4 & \text{if } x > 6 \end{cases} \)

(b) \( \int \frac{1 - t}{\sqrt{9 + 2t - t^2}} \, dt \)

(c) \( \int \frac{\sinh x}{1 + \cosh^2 x} \, dx \)

6. (12 pts) A radioactive substance decreases in mass by 17% in 3 years. What is the half-life of the substance?

7. (22 pts)

Shown above is the graph of \( y = g(x) \) defined on \((-3, 5)\), and the line tangent to \( g \) at \((1, -1)\).

(a) Find the value of \( \lim_{x \to 0} |g(x) - 5| \).

(b) Find the value of \( \lim_{h \to 0} \frac{g(1 + h) - g(1)}{h} \).

(c) Suppose \( g \) is the derivative of a function \( f \) so that \( g(x) = f'(x) \). Estimate the interval(s) on which \( f \) is increasing, or write NONE if \( f \) is a decreasing function.

(d) Find the following values for the inverse function of \( g \).

i. \( g^{-1}(2) \)

ii. \( (g^{-1})'(-1) \)