Final Exam: Comprehensive Part
100 points total for this part. You have 120 minutes for both parts together.

1. (a) (5 pts) Compute $f'(5)$ if $f(x) = x^{-2}$.
   (b) (5 pts) Use the definition of the derivative to compute $f'(5)$ if $f(x) = x^{-2}$.

2. (a) (5 pts) Find $dy/dx$ if
   $$y = 2\sqrt{x} + 6e^x$$
   (b) (5 pts) Compute
   $$\int 2\sqrt{x} + 6e^x \, dx$$

3. (10 pts) The equation
   $$x^2 - xy + y^2 = 4$$
is an ellipse. $(2, 0)$ is a point on this ellipse. Find the equation of the tangent line to this ellipse at this point. (Hint: There is no need to sketch any graph.)

4. Consider the curve
   $$y = \frac{4 - x}{x - 1}$$
   (a) (5 pts) Is this curve even, odd, or neither?
   (b) (5 pts) Find the intercepts (locations where the graph crosses the $x$ and the $y$ axes).
   (c) (5 pts) Find the intervals on which the curve is increasing and decreasing.
   (d) (5 pts) Sketch the graph, showing any asymptotes.

5. (10 pts) Find the absolute maximum and minimum of $f(t) = 2t - \tan t$ on the interval $[0, \pi/4]$. 
6. (a) (5 pts) Bismuth-210 is a radioactive substance whose mass decays exponentially. It has a half-life of 5.0 days. A sample originally has a mass of 800 mg. Find a formula for the mass \( y(t) \) remaining after \( t \) days.

(b) (5 pts) Find the mass remaining after 15 days.

7. (10 pts) Define

\[
\lim_{x \to a} f(x) = L
\]

You may use either the sentence definition written many times in lecture, or you may use the \( \epsilon - \delta \) definition.

8. (10 pts) Compute

\[
\int_{3}^{7} \frac{\cos x}{\sin^4 x} \, dx
\]

9. (10 pts) Find the area between \( y = e^x \) and \( y = 1/x \) on the interval \([1, 2]\).

**Extra Credit.** (3 pts) Show that

\[
\frac{d}{dx} \arccsc x = \frac{1}{x \sqrt{x^2 - 1}}
\]

You may use known derivatives of trigonometric functions, but not, naturally, the derivatives of inverse trigonometric functions. You may use standard trigonometric identities.