Please answer the following questions. Your answers will be evaluated on their correctness, completeness, and use of mathematical concepts we have covered. Please show all work and write out your work neatly. Answers without supporting work will receive no credit. The point values of the problems are listed in parentheses.

1. (10 points each) Evaluate the following definite and indefinite integrals.

   (a) \( \int_1^2 (8x^3 + 3x^2) \, dx \)

   (b) \( \int (1 - x) \sqrt{2x - x^2} \, dx \)
(c) $\int_{0}^{\pi/8} \sec 2x \tan 2x \, dx$

(d) $\int \frac{\cos x}{2 + \sin x} \, dx$

(e) $\int_{0}^{1} \frac{x^2 + 1}{x^3 + 3x + 1} \, dx$
2. (3 points each) Which of the following functions have an inverse defined for all real numbers \( x \)? You must explain your answers. You do not need to find the inverse functions.

(a) \( f(x) = x^3 + 4x - 1 \)

(b) \( f(x) = x^3 - 3x + 1 \)

(c) \( f(x) = \sqrt{x^2 + 1} \)

(d) \( f(x) = \cos x \)
3. (7 points each) Find the derivative with respect to $x$ of each of the following functions.

(a) $f(x) = \int_{\pi}^{x} \tan(t^2) \, dt$

(b) $f(x) = \int_{1}^{\cos x} \sqrt{1 - t^2} \, dt$

(c) $f(x) = \int_{\sqrt{x}}^{x} \frac{\cos t}{t} \, dt$
(d) \[ f(x) = \ln \frac{(x^3 + 1)^4 \sin^2 x}{\sqrt{x}} \]

4. (6 points) Express the quantity below as a single logarithm.

\[ \ln \sin^2 x + 4 \ln | \tan x | - 3 \ln (x^2 + 1) \]
5. (4 points) Determine whether the function graphed below has an inverse and graph the inverse of the function on the axes provided.