Show all your work. Jumping to the right answer without minimum reasoning deserves no credit. Answer each numbered problem on a separate answer sheet, and write your name and problem number on each sheet. No electronic devices are allowed. Honor Pledge at the first page.

1. [30 points] Let \( f(x) = x^x \) for \( x > 0 \).

(1) [10 points] Find the limit \( \lim_{x \to 0^+} f(x) \).

(2) [10 points] Show that \( f \) has an inverse for \( x > \frac{1}{e} \).

(3) [10 points] Find \( (f^{-1})'(1) \).

2. [25 points]

(1) [15 points] Find the derivative of
\[
 f(x) = \int_{2^x}^{(\sin x)^5} \sqrt{1 + t^2} \, dt.
\]
(No need to simplify.)

(2) [10 points] Simplify the expression \( \cos(\tan^{-1}(x^2)) \).

3. [15 points] Find the limit \( \lim_{x \to 1} \frac{x - 1 - \ln x}{(x - 1)^2} \).

4. [30 points] Compute the following integrals.

(1) [10 points] \( \int_0^{\pi/6} \frac{2 \cos(2x)}{\sqrt{1 - \sin^2(2x)}} \, dx \)

(2) [10 points] \( \int \frac{1}{x^2 + 2x + 5} \, dx \)

(3) [10 points] \( \int_0^{\pi/2} x \cos x \, dx \)