Instructions. Please justify your answers to each of the following problems. Answers without any explanation (or work shown) will not receive credit.

(1) Compute the derivatives of the following functions:
   (a) \( h(x) = e^{\sqrt{x}} \)
   (b) \( p(x) = \sqrt{x^3 + \sin x + 2} \)
   (c) \( w(x) = (\cos x)^2 \)

(2) Explain the geometric meaning behind \( \int_{a}^{b} f(x) \, dx \). Draw a picture for illustration.

(3) Consider the function \( f(x) \) defined piecewise:

\[
 f(x) = \begin{cases} 
 -2x + 3 & \text{for } -2 \leq x < 1 \\ 
 x & \text{for } 1 \leq x \leq 3 
\end{cases}
\]

(a) Draw an accurate sketch for the graph of \( f(x) \).
(b) Find the exact area under the graph of \( f(x) \) from \( x = -2 \) to \( x = 3 \) using geometry rules (using formulas for the areas of rectangles, triangles, trapezoids, etc).
(c) Find the exact area under the graph of \( f(x) \) from \( x = -2 \) to \( x = 3 \) using the Fundamental Theorem of Calculus (FTC). Hint: The area you want is given by the integral \( \int_{-2}^{3} f(x) \, dx \). To evaluate this integral, split it into two pieces, \( \int_{-2}^{1} + \int_{1}^{3} \) where you need to fill in the blanks, and then apply FTC to each integral.

(4) Recall the definition of anti-derivative. We say that \( F(x) \) is anti-derivative of \( f(x) \) if \( F'(x) = f(x) \). For example, an anti-derivative of \( 2x \) is \( x^2 \) because \( (x^2)' = 2x \). Note that \( (x^2 + 3)' = 2x \), so \( x^2 + 3 \) is another anti-derivative. Similarly, \( (x^2 + 17)' = 2x \), so \( x^2 + 17 \) should also be anti-derivative of \( 2x \). We see that any function of the form \( F(x) = x^2 + C \) is a legitimate anti-derivative of \( f(x) = 2x \). Here \( C \) is an arbitrary constant. We say that \( x^2 + C \) is a general anti-derivative of \( f(x) = 2x \). As another example, the general anti-derivative of \( g(x) = 2 \cos x \) is \( G(x) = 2 \sin x + C \). Find the general anti-derivative of the following functions below:
   (a) \( f(x) = 5 \)
   (b) \( f(x) = x + 3 \)
   (c) \( f(x) = 3x^2 + \sin x \)
(d) \( f(x) = 1/x \)

(e) \( f(x) = x^n \) where \( n \neq -1 \)

(5) Use the Fundamental Theorem of Calculus (FTC) to find the area under the curve given by the graph of \( f(x) = x^2 + 1 \) from \( x = 1 \) to \( x = 3 \). Draw a picture to illustrate the area that you have computed.

(6) Use the Fundamental Theorem of Calculus (FTC) to find the area under the curve given by the graph of \( f(x) = \frac{2}{x} \) from \( x = 1 \) to \( x = e^3 \). Draw a picture to illustrate the area that you have computed.

(7) Use the Fundamental Theorem of Calculus (FTC) to find the area under the curve given by the graph of \( f(x) = e^x \) from \( x = 0 \) to \( x = 2 \). Draw a picture to illustrate the area that you have computed.

(8) Use the Fundamental Theorem of Calculus (FTC) to evaluate the following integrals:

(a) \( \int_{\pi/6}^{\pi} (\sin x + \cos x + x) \, dx \)

(b) \( \int_{1}^{3} \frac{x^3 + 4x^2}{x} \, dx \)

(c) \( \int_{2}^{4} e^x + \sqrt{x} \, dx \)

(d) \( \int_{-2}^{2} 3x^2 + 4x - 5 \, dx \)