Instructions: Do all the problems. Circle your answers. To get credit, you need to show your work. The answer alone will not be counted as a solution.

1. (4 pts each) Evaluate the limit (which can also be infinite, that is, $+\infty$ or $-\infty$), if it exists:

(a) $\lim_{x \to 1} (x^4 - 3x^3 + x - 1) =$

(b) $\lim_{x \to 2} \frac{x - 2}{x^3 - 2x^2} =$

(c) $\lim_{x \to -1} \frac{x + 1}{x^2 - 4x - 5} =$

(d) $\lim_{x \to 0} \frac{x + 1}{x(x - 3)} =$
2. (4 pts) Find the vertical asymptote of the function

\[ f(x) = \frac{x}{x - 2}. \]

3. (10 pts) Use the limit definition of derivative to calculate \( \frac{d}{dx}(x^2 + x) \).
4. (5 pts) Sketch the graph of a function that is continuous everywhere except at $x = -1$ and at $x = 3$. This function should also be continuous from the left both at $x=-1$ and at $x=3$, and have a limit from the right at $x=-1$ and have a vertical asymptote at $x=3$.

5. (10 pts) Making use of the definition of continuity, determine where the following function is continuous and where it is discontinuous:

$$f(x) = \begin{cases} 
  x + 1 & \text{if } x \geq 0, \\
  x^2 & \text{if } x < 0.
\end{cases}$$
6. (5 pts each) Find the horizontal asymptotes of the graphs of the following functions as $x \to +\infty$:

(a) $y = \frac{x}{x^2 - x - 2}$

(b) $y = \frac{x^2}{x^2 - x - 2}$
7. Use the Rules of Differentiation to differentiate the following functions:

(a) (3 pts)

\[ \frac{d}{dx} (x^2) = \]

(b) (3 pts)

\[ \frac{d}{dx} (x^2 + 2x + 20) = \]

(c) (3 pts)

\[ \frac{d}{dx} (\sqrt{x^3}) = \]

(d) (3 pts)

\[ \frac{d}{dx} (x^5 + \frac{2}{x^3}) = \]

(e) (3 pts)

\[ \frac{d^2}{dx^2} (\sin x + 1) = \]
(f) (5 pts)

$$\frac{d}{dx}(\cos x + \frac{1}{x}) =$$

(g) (5 pts)

$$\frac{d^2}{dx^2}(x^2 + 1) =$$
8. (10 pts) Find an equation of the tangent line to the parabola \( y = x^2 + 2x + 3 \) at the point \((1, 6)\).

9. (10 pts) Prove (by calculations) that the function \( y = |x| \) is not differentiable at \( x = 0 \).