1. [8] Fill in the blanks to correctly complete each statement (no work necessary):

i) True or False: \( \lim_{x \to 0} \left( \cos \left( \frac{1}{x} \right) \right) = 0 \). 

ii) By definition, \( f \) is continuous at \( x = a \) if 

iii) List all \( x \) values where the function \( h(x) = \begin{cases} 3 - x & \text{if } x < 2 \\ x^2 & \text{if } x \geq 2 \end{cases} \) is discontinuous: 

iv) An example of a function that is continuous but not differentiable at \( x = 0 \) is \( f(x) = \) 

2. [16] Below is the graph of a function \( f \). Use the graph to answer the following questions as best you can (no work necessary). Remember: \( \infty \) or \( -\infty \) is sometimes a better answer than just DNE.

i) \( \lim_{x \to \infty} f(x) = \) 

ii) \( \lim_{x \to -2^+} f(x) = \) 

iii) \( \lim_{x \to 3^-} f(x) = \) 

iv) \( \lim_{x \to 1^-} f(x) = \) 

v) \( \lim_{x \to 1^+} f(x) = \) 

vi) \( f'(-3) \) appears to have a value of: 

vii) \( x \)-values where \( f \) is discontinuous: 

viii) \( x \)-values where \( f \) is not differentiable:
3. [5 each] Evaluate each of the following limits, with computation and/or explanation for each answer.

a) \( \lim_{x \to 3} \left( \frac{x^2 - 3x}{x^2 + 2x - 15} \right) \)

b) \( \lim_{x \to 2} \left( \frac{x}{\sqrt{x^2 + 1}} \right) \)

c) \( \lim_{x \to -\infty} \left( \frac{8 - 4x - 4x^2}{7x^2 - 28} \right) \)

d) \( \lim_{x \to 3^+} \left( \frac{1 - x}{x - 3} \right) \)
4. Sketch the graph of a function $f$ that satisfies all of the conditions listed below.

- $f$ is continuous everywhere except $x = 2$
- $\lim_{x \to 2^-} (f(x)) = 3$
- $\lim_{x \to 2^+} (f(x)) = -\infty$
- $f(2) = 0$
- $\lim_{x \to \infty} (f(x)) = \lim_{x \to -\infty} (f(x)) = 1$
- $f(0) = 4, f'(0) = 0$

5. Use the limit definition of the derivative to find $f'(x)$ for the function $f(x) = 3x + \frac{5}{x}$. 
6. [6 each] Differentiate each function using the differentiation formulas from 2.3-2.5. No need to simplify your answers.

a) \( f(x) = \frac{3}{x^4} - 5\sqrt{x} \)

b) \( g(x) = (x^2 + 3)^4 \sin(x) \)

c) \( h(t) = \frac{\cos(3x)}{x^4 + 5x} \)

7. [6] Find an equation of the line which is tangent to the curve \( y = x^4 - 5x^2 \) at the point \((1, -4)\).
8. [8] Do one of the following two questions. If you try both, your better effort will be counted.

| Use the Intermediate Value Theorem to prove that the equation $x^3 - x - 8 = 0$ has a root in the interval $(2, 3)$. | Use the Squeeze Theorem to prove that $\lim_{x \to 0} \left( x^2 \cos \left( \frac{3}{x} \right) \right) = 0$. |
9. Suppose that the displacement (in meters) of a particle moving in a straight line is given by 
$s = 3 + 12t - t^3$, where $t$ is measured in seconds.

a) [3] What is the instantaneous velocity of the particle at time $t = 2$?

b) [4] What is the average velocity of the particle during the interval $1 \leq t \leq 3$?

c) [3] Part of the graph of $s(t)$ is shown on the right. Draw in the lines whose slopes are represented 
by the answers from parts (a) and (b).