**Problem 1.** Compute the following limits if they exist. Show enough work to justify your computation, or your claim that the limit does not exist.

(a)

$$\lim_{x\to 9} \frac{3-\sqrt{x}}{9-x}$$

(b)

$$\lim_{x\to -\infty} \frac{3x^3+\sqrt[3]{x}}{\sqrt{9x^6+2x^2+1}+x}$$

(c)

$$\lim_{x\to 1} \frac{\sin^2(x-1)}{(x-1)^2} =$$

(d)

$$\lim_{x\to 3} \frac{x-5}{(x-3)^2} =$$

**Problem 2.**

(a) Using the Squeeze Theorem, show that

$$\lim_{x\to 3} \frac{x-3}{1+\sin^2\left(\frac{2\pi+e+7}{x-3}\right)} = 0.$$

(b) Let

$$g(x) = \begin{cases} \frac{x^2-1}{x-1} & x > 0 \\ x^2+1 & x < 0 \end{cases}$$

If possible, define an extension of $g$ that is continuous at all real numbers.

**Problem 3.**

(a) **Directly from the definition of derivative,** compute the derivative of $f(x) = x^2 + \sqrt{x}$ at $a = 2$.

(b) **Naming each derivative rule used explicitly**, compute the derivative of $g(x) = x\sqrt{x^2 + 1}$.

**Problem 4.**

(a) Find an equation of the line tangent to $y = \frac{x^2-1}{x^2+1}$ at the point $(0, -1)$.

(b) Use a linear approximation to estimate $\sqrt{4.01}$.

(c) Give equation for the linear approximation of the function $f(x) = x\sin(x)$ near the point $a = \pi/2$.

**Problem 5.** Compute the derivatives of the following functions using methods we have learned in class. Show enough work to justify your answers.

(a) $f(x) = \sec\left(\frac{\sqrt{x^2+1}}{x+2}\right)$

(b) $g(x) = \sqrt[4]{\frac{x^3+\cos(x^2)}{\sin(x^3)+1}}$