Problem 1.
Solve the following quadratic equations.
(a) $8x^2 + 2x - 3 = 0$  
(b) $x^2 - 2x - 5 = 0$

Problem 2.
Solve the following inequalities.
(a) $x^2 + 2x - 15 \geq 0$  
(b) $x^2 + x + 1 \leq 0$  
(c) $\frac{2x + 1}{2 - x} \leq 1$

Problem 3.
Find the composite functions $f \circ g$ and $g \circ f$ where
\[
f(x) = \sqrt{x + 1} \quad \text{and} \quad g(x) = \frac{1}{x - 1}.
\]
Simplify your answers as much as you can!

Problem 4.
If $f(x) = \frac{1}{x}$, find and simplify
\[
\frac{f(-1 + h) - f(-1)}{h}, \quad \text{where} \ h \neq 0 \ \text{and} \ h \neq 1.
\]

Problem 5.
Sketch the graph of the following functions.
(a) $f(x) = \sqrt{x + 1} - 1$  
(b) $f(x) = |x-1| + 1$  
(c) $f(x) = \begin{cases} -2x + 4 & \text{if } x < 1 \\ 4 & \text{if } x = 1 \\ x^2 + 2 & \text{if } x > 1 \end{cases}$  
(d) $f(x) = \begin{cases} |x-2| & \text{if } x \neq 2 \\ 1 & \text{if } x = 2 \end{cases}$

Problem 6.
Find an equation of the line that passes through the point $(-1, 0)$ and is perpendicular to the line with the equation $4x + 5y + 16 = 0$.

Problem 7.
For $f(x) = \frac{2x}{x + 5}$ and $g(x) = \frac{x}{3x - 8}$, find $(f \circ g)(x)$ and $(g \circ f)(x)$. Simplify your results!

Problem 8.
Find the following limits.
(a) $\lim_{x \to -1} \frac{3x^2 + 4x + 1}{x + 1}$  
(b) $\lim_{x \to \infty} \frac{-2x^4 + 3x^3 - 7x - 10}{3x^4 + 6x^2 - x + 100}$

Problem 9.
Find the following limits
(a) $\lim_{x \to -2} \frac{x^2 - 4}{x + 2}$  
(b) $\lim_{x \to 4} \frac{x - 4}{\sqrt{x} - 2}$  
(c) $\lim_{x \to 1} \frac{\sqrt{x + 3} - 2}{x - 1}$  
(d) $\lim_{x \to 0} \frac{1 - \cos(2x)}{3x^2}$

Problem 10.
Determine the values of $x$, if any, at which the given function is discontinuous. At each point of discontinuity, state the condition(s) for continuity that are violated.
\[
f(x) = \begin{cases} \frac{x^2 - 1}{x+1} & \text{if } x \neq -1 \\ 1 & \text{if } x = -1 \end{cases}
\]

Problem 11.
Explain in details why $f(x) = \begin{cases} 2x - 3, & \text{if } x \leq -1 \\ x^2 - 4, & \text{if } x > -1 \end{cases}$ is NOT continuous at $x = -1$.

Problem 12.
Let $y = -x^2$.
(a) Find the average rate of change of $y$ with respect to $x$ on the interval $[2, 3]$.
(b) Find the (instantaneous) rate of change at $x = 3$.

**Problem 13.**
Find the derivatives of the following functions

(a) $g(s) = 2s^2 - \frac{4}{s} + \frac{2}{\sqrt{s}}$  
(b) $h(x) = \left(x + \frac{1}{x} + \frac{1}{x^2}\right)^5$  
(c) $F(x) = \sqrt{\frac{x^2 + 1}{x^4 + 2} + 10}$

**Problem 14.**
For the function

$$g(t) = \sqrt{2t^2 + 3}$$

find $g''$ and $g'''$.

**Problem 15.**
Differentiate the following functions with respect to the indicated variable.

(a) $h(t) = \frac{t^2 - 3t + 1}{t + 1}$  
(b) $f(x) = \sqrt{c^2x^2 + 2}$  
(c is a constant)