Goal: complete the following problems without using notes or calculators.

1. Calculate the following limits.

   (a) $\lim_{x\to 0} \frac{\sqrt{3x+4}-2}{x}$

   (b) $\lim_{x\to 3} \left(\frac{\sin(3-x)}{x-3} + \frac{3x^2+x-2}{x+1} \right)$

   (c) $\lim_{x\to 0} 3x^2 \cos(\frac{2}{x})$

   (d) $\lim_{x\to 3^-} \frac{|x-3|}{x-3}$

2. Use the definition of the derivative to find the derivatives of the following functions.

   (a) $f(x) = 3x^2 - 2x + 10$

   (b) $g(x) = \sqrt{3x - 5}$

   (c) $h(x) = \frac{1}{t^2}$

3. If possible, find the equation of the tangent line to the above curves when $x = 1$.

4. Find the derivatives of the following functions.

   (a) $f(x) = \cos(\sin(x^2))$

   (b) $y = \cos(\frac{x}{2})\sqrt{x^2+4}$

   (c) $\frac{3x^2+1}{x-4}$

   (d) Find $\frac{dy}{dx}$ when $y^2 - 19 = -3xy + x$

5. Show that the function $f(x) = x^5 - 2x^3 - 2$ has a zero (root/x-intercept) in the interval $[0, 2]$. Make sure to state which theorem you're using and why it applies.

6. Show that the function $f(x) = \frac{x^3-2x^2+1}{x-2}$ is 0 for some real value of x. Make sure to state which theorem you're using and why it applies.

7. Consider the following function.

$$f(x) = \begin{cases} 2x+3 & x \leq -2 \\ 1 & -2 < x < 0 \\ 0 & x = 0 \\ -x+4 & x > 0 \end{cases}$$

(a) Graph the function.

(b) Use the graph to determine $\lim_{x \to 0} f(x)$.

(c) Use the graph to determine $\lim_{x \to -2^-} f(x)$.

(d) Determine the intervals on which $f(x)$ is continuous. (Be clear about endpoints).

(e) Determine the intervals on which $f(x)$ is differentiable. (Be clear about endpoints).