Math 124 - Winter 2017
Exam 1
January 31, 2017

Name: _____

Section: _____

Student ID Number: _____

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- There are 6 pages of questions. Make sure your exam contains all these questions.
- You are allowed to use a Ti-30x IIS Calculator model ONLY (**no other calculators allowed**). And you are allowed one **hand-written** 8.5 by 11 inch page of notes (front and back).
- Leave your answer in exact form. Simplify standard trig, inverse trig, natural logarithm, and root values. Here are several examples: you should write $\sqrt{4} = 2$ and $\cos\left(\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$ and $\frac{7}{2} - \frac{3}{5} = \frac{29}{10}$ and $\ln(1) = 0$ and $\tan^{-1}(1) = \frac{\pi}{4}$.
- Show your work on all problems. The correct answer with no supporting work may result in no credit. **Put a box around your FINAL ANSWER for each problem and cross out any work that you don't want to be graded.**
- If you need more room, use backs of the pages and indicate to the grader that you have done so.
- Raise your hand if you have a question.
- There may be multiple versions of the exam so if you copy off a neighbor and put down the answers from another version we will know you cheated. Any student found engaging in academic misconduct will receive a score of 0 on this exam. All suspicious behavior will be reported to the student misconduct board.
  DO NOT CHEAT OR DO ANYTHING THAT LOOKS SUSPICIOUS!
  WE WILL REPORT YOU AND YOU MAY BE EXPELLED!
  Keep your eyes down and on your paper. If your TA sees your eyes wandering they will warn you only once before taking your exam from you.
- You have 80 minutes to complete the exam. Budget your time wisely.
  SPEND NO MORE THAN 10 MINUTES PER PAGE!

1. (8 pts) Determine the values of the following limits or state that the limit does not exist. If it is correct to say that the limit equals ∞ or $-\infty$, then you should do so. **In all cases, show your work/reasoning. You must use algebraic methods where available. And explain in words your reasoning if an algebraic method is not available.**

   (a) $\lim_{x\to 3^-} \dfrac{x^2-4}{x-3}$

   (b) $\lim_{t\to 0} \left(\dfrac{2}{t(1+3t)^2} - \dfrac{2}{t} \right)$

   (c) $\lim_{x\to\infty} \dfrac{4x^2 - \sqrt{x^4+2x-1}}{e^{-x}+3x-\sqrt{5x^3+16x^4}}$

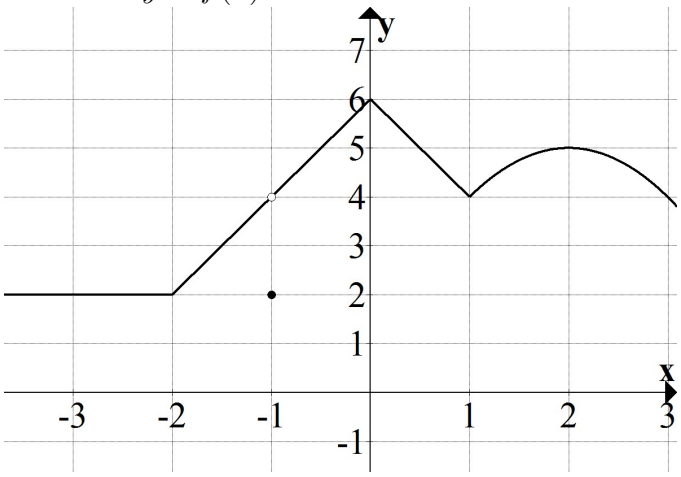
2. (9 pts)

(a) Compute $\lim_{t\to\pi/2} \dfrac{\sin(t) - \sqrt{\sin^2(t) + 4\cos^2(t)}}{3\cos^2(t)}$

(b) Let $y = \dfrac{5}{2x} + \dfrac{4x}{5\sqrt[4]{x}} - \dfrac{4\tan(x)}{x^5}$. Find $\dfrac{dy}{dx}$. (You don't have to simplify)

(c) Let $f(t) = 5te^t\cos(t)$. Find the slope of the tangent line to $f(t)$ at $t = \pi$.

3. (10 pts) Consider the function $y = f(x)$ shown:



Use the graph to estimate/compute the answer to the following:

(a) Find the solution(s) to $f'(x) = 0$.

(b) Name the value(s) of x at which $y = f(x)$ is not differentiable.

(c) Compute $\lim_{x \to -1} \left(f(x) + \dfrac{|x-5|}{\sec(\pi x/6)} + \dfrac{\sin(x+1)}{x+1} \right)$.

(d) If $g(x) = \dfrac{f(x)}{x^2}$, then find value of $y = g'(x)$ at $x = \dfrac{1}{2}$.

4. (10 pts) Consider $f(x) = \begin{cases} bx^2 + 3ax - 10 & , \text{ if } x < 1; \\ ax - b - 2 & , \text{ if } 1 \leq x \leq 3; \\ \dfrac{x^2 - 9}{x - 3} & , \text{ if } x > 3, \end{cases}$ where a and b are constants.

(a) Find the values of a and b that make f continuous everywhere.

(b) Using the values for a and b from part (a), is the function $f(x)$ differentiable at $x = 1$? Clearly say NO or YES, and explain your answer in words. (Hint: Use all our derivative rules to analyze $f'(x)$ near $x = 1$.)

5. (11 pts) A water balloon is thrown upward from a dorm window, it goes up for a bit then ultimately falls down to the ground and *coincidentally* lands near your math instructor. The height of the balloon is given by $s(t) = 80 - 16t^2 + 8t$ where t is in seconds since it was thrown and $s(t)$ is in feet.

   (a) What is the average velocity of the balloon from $t = 0$ to $t = 2$ seconds? (include units)

   (b) Find and *completely simplify* the formula for the average velocity of the balloon from t to $t + h$. That is, find and completely simplify $\dfrac{s(t+h) - s(t)}{h}$.

   (c) Find the instantaneous velocity at the time the balloon hits the ground? (include units)

6. (12 pts) **NOTE: The two questions below are unrelated**.

(a) Find all points (a, b) at which the function $y = \dfrac{x^2}{3x - 6}$ has a horizontal tangent line.

(b) Find all points (a, b) on the curve $y = \dfrac{5x}{3} + 4x^3 - 17$ where the tangent line at (a, b) also passes through the point $(0, 10)$.