

Calculus I Midterm

October 16–17, 2012

Important Directions

- **You may not collaborate on this exam; do not work with others.**
- You may consult your notes, your textbook, or any other written material while doing this test. You may use calculators and computer programs.
- This exam is untimed, but unless I hear to the contrary, I expect you to finish by 11am on Thursday, October 18.
- When you are done with the exam, give it to me or slip it under my office door. Don't put it my mailbox.
- If you have clarifying questions on the exam, please ask me. Do not ask the TAs.
- To receive full credit on most of these problems you must show your work clearly.

1. Short Answers. No explanations needed.

- (a) Which function dominates as $x \rightarrow \infty$: $99x^3$ or 3^x ?
- (b) Which function dominates as $x \rightarrow \infty$: $x^{1/3}$ or x^{-8} ?
- (c) What is the period of $g(x) = 5 \cos(6x) - 3$?
- (d) Solve for t : $7^{t+2} = 613$.

2. Let $f(x) = -3x^2$.

- (a) Algebraically (i.e. without making a table of numbers or using a calculator) determine the derivative of $f(x)$.
- (b) Use the power rule to determine the derivative of $f(x)$.

3. Numerically determine the derivative of $\log(5x)$ when $x = 2$. (Use difference quotients. Do not use any differentiation short cuts you might have learned in other classes.)

4. The number of crazed squirrels on campus grows at a rate of 10% a day. On Monday, October 1, there are 100 crazed squirrels on campus.

- (a) Write an equation for $P(t)$, the number of crazed squirrels, t days after Monday, October 1.
- (b) Sketch a graph of the number of crazed squirrels as a function of time. Be sure to label the axes and any intercept(s).
- (c) On what day will there be approximately 1000 crazed squirrels on campus?

5. (a) Sketch a function that has a positive first derivative for $x < -5$, a derivative of zero for $-5 < x < 5$ and a negative first derivative for $x > 5$.
- (b) Call this function $f(x)$. On the same axes as your original graph, sketch $f(x - 3)$ and $f(x) - 3$. Make it clear which function is which.
- (c) Is your $f(x)$ invertible? Is it possible to come up with an $f(x)$ that satisfies the criteria of question 5a that is invertible? Why or why not?
6. Let $F(T)$ be the cost of heating your house, in dollars per day, when the average outside temperature is T Celsius degrees.
- (a) Make a rough sketch a possible graph of $F(T)$. (There are many possible answers.)
- (b) What is the meaning of $F(4) = 3.20$?
- (c) What is the meaning of $F^{-1}(5) = -2.5$?
- (d) What are the units of $F'(T)$?
- (e) In practical terms what does $F'(-4) = -.17$ mean? Be sure to explain why the minus sign is there.
7. For each of the graphs in Fig. 1, find a possible formula for the function. If there are any constants in your formula, indicate if those constants are positive or negative.

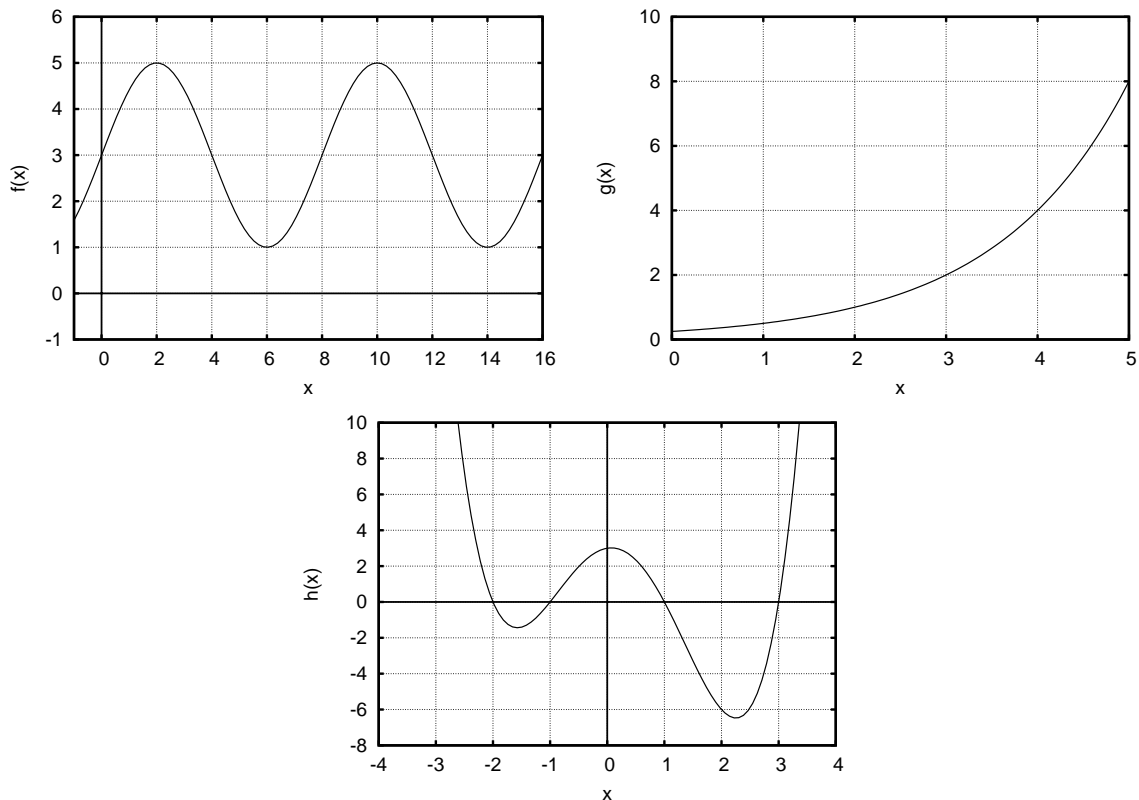


Figure 1: Graphs for problem 7.

8. Let $C(q)$ be the cost, in dollars, of q kilograms of kale. Suppose that $C(20) = 45$ and that $C'(10) = 3.3$.

(a) What are the units of $C'(q)$?

(b) Estimate $C(18.3)$.

9. For the function in Fig. 9:

(a) Estimate $f'(1.5)$.

(b) Estimate $f'(5)$.

(c) Sketch $f'(x)$.

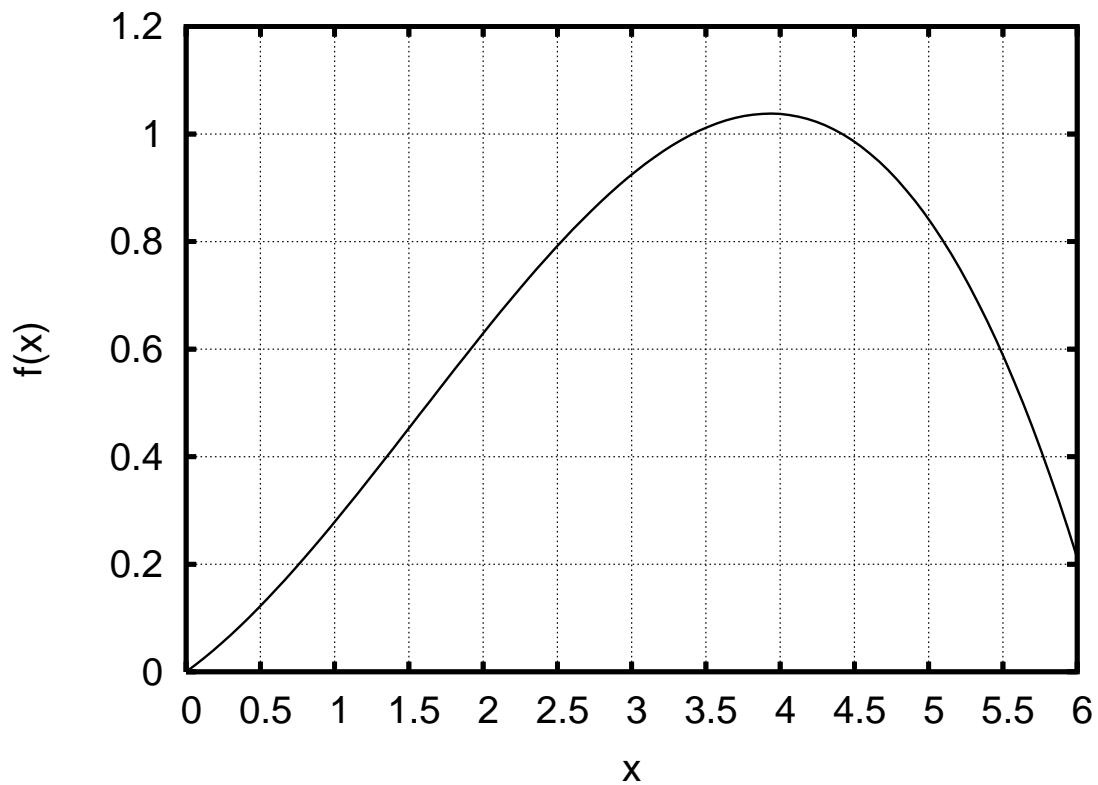


Figure 2: Graph for problem 9.

10. Answer the following questions for the function in Fig. 3. Briefly explain or illustrate your answer.

- (a) Which is larger $f(2)$ or $f(4)$?
- (b) Which is larger $f'(2)$ or $f'(4)$?
- (c) Which is larger $f'(2)$ or $\frac{f(4)-f(2)}{4-2}$?
- (d) Is $f''(3)$ positive or negative?

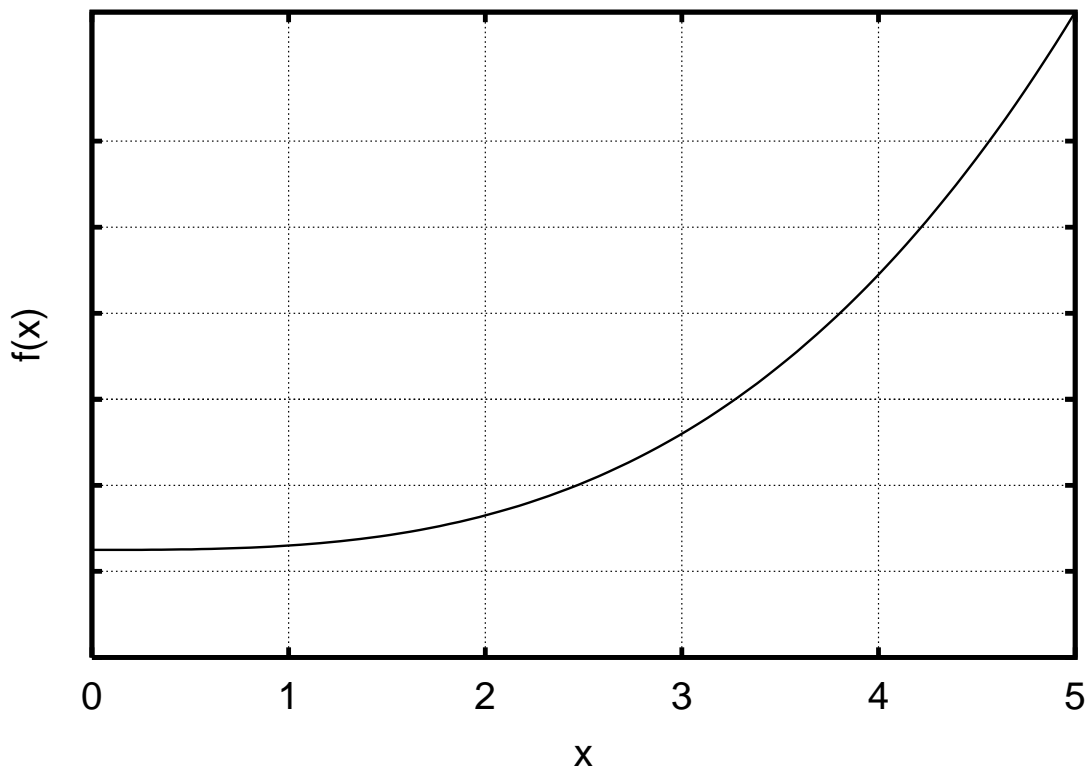


Figure 3: Graph for problem 10.

11. Answer the following questions for the function $h(x)$ shown in Fig. 4. Briefly explain or illustrate your answer.

- (a) For what values of x is $h(x)$ positive?
- (b) For what values of x is $h'(x)$ positive?
- (c) For what values of x is $h''(x)$ positive?

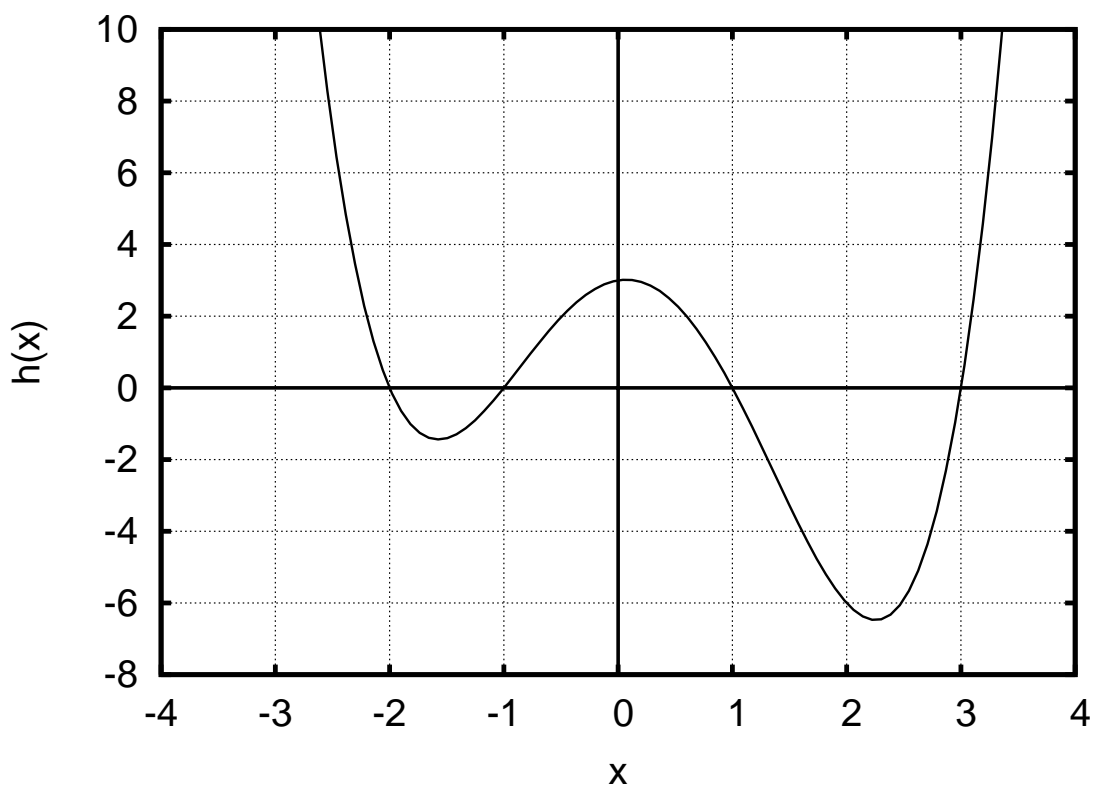


Figure 4: Graph for problem 11.