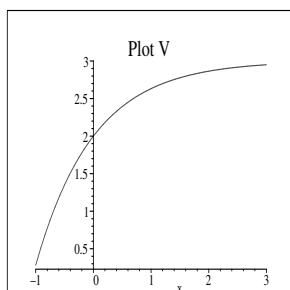
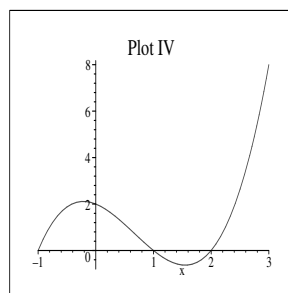
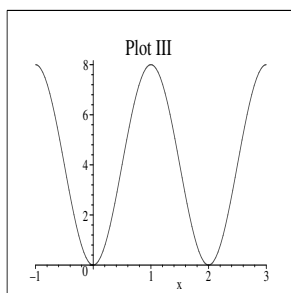
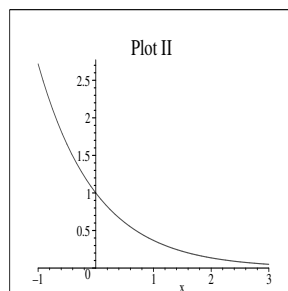
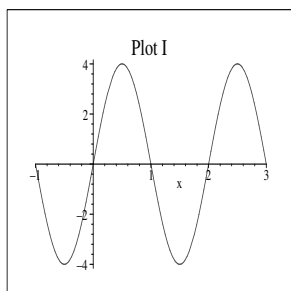


Holy Cross College, Fall Semester, 2004
MATH 131, Section 01, Final Exam
Monday, December 13, 2:30 PM
 Professor Little

1. [5 points each] Circle the number of the graph showing each of the following functions.

- (a) $f(x) = 3 - e^{-x}$ I II III IV V
- (b) $f(x) = x^3 - 2x^2 - x + 2$ I II III IV V
- (c) $f(x) = 4 \sin(\pi x)$ I II III IV V
- (d) $f(x) = 4 - 4 \cos(\pi x)$ I II III IV V



2. [20 points] One of the functions given in the following table is linear and the other is exponential. Find formulas of the appropriate type for each.

x	1	2	3	4	5
$f(x)$	1.2	0.6	0.3	0.15	0.075
$g(x)$	-2.3	-0.6	1.1	2.8	4.5

3.

- (a) [15 points] The depth of water in a tank oscillates sinusoidally once every 4 hours. The smallest depth is 2 feet and the maximum depth is 5 feet, which occurs at $t = 0$. Find a formula for the depth $d(t)$ if t is the time in hours.
- (b) [5 points] How fast is the depth changing at $t = 1.3$ hours? Is it increasing or decreasing?

4. Compute the following limits [5 points each]. Any legal method is OK.

- (a) $\lim_{x \rightarrow 1} \frac{x^2 + 1}{x - 3}$
- (b) $\lim_{x \rightarrow 2} \frac{x^2 - 4x + 4}{\cos(x - 2) - 1}$
- (c) $\lim_{x \rightarrow \infty} \frac{5x^2 - x + 21}{3x^2 + x + 1}$

5.

- (a) [5 points] State the limit definition of the derivative:
- (b) [10 points] Use the definition to compute $f'(x)$ for $f(x) = \sqrt{x}$.
- (c) [10 points] Find the equation of the tangent line to the graph $y = \sqrt{x}$ at the point $[4, 2]$.

6. Compute the following derivatives using the derivative rules. You need not simplify. [5 points each]

- (a) $f(t) = t^3 - \frac{1}{\sqrt[3]{t}} + \pi^t$.
- (b) $g(x) = \frac{x^2 - 2}{\cos(x) + 1}$
- (c) $h(z) = \ln(4z^2 + 2e^{\tan^{-1}(z)})$

- (d) Find $\frac{dy}{dx}$ if $x^2y - 2y^3 = 3$.

7. Consider the family of curves defined by $y = f(x) = x^4 + 2ax^2$, where a is any fixed real number.

- (a) [10 points] Find the *critical points* of f , construct a sign diagram for $f'(x)$ in the case that $a < 0$. Which of your critical points are local maxima and which are local minima?
- (b) [10 points] Repeat part a, but assume now that $a > 0$.
- (c) [10 points] How many different *inflection points* does the graph $y = f(x)$ have if $a < 0$? Explain.

8. [15 points] A cubical block of dry ice (solid CO_2) is evaporating and losing volume at the rate of $10 \text{ cm}^3/\text{min}$. How fast are the sides of cube shrinking when the block has volume 125 cm^3 ? Give the units of your answer.

9. [20 points] Ship A travels along the path given by the parametric curve $x = t, y = t^2$. At the same time, ship B travels along the curve $x = t, y = 4t - 5$. At what time are the two ships *closest to one another*?

10. A car moves along a straight line road with acceleration at time t (seconds) given by $a(t) = \cos(t) - \frac{t^2}{100}$ (meters per second per second).

- (1) [7.5 points] Find the velocity v of the car as a function of time if $v(0) = -2$ meters per second.
- (2) [7.5 points] Find the position x of the car as a function of time if $x(0) = 0$ meters.