

Your Name

Your Signature

Student ID #

Quiz Section

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Professor's Name

TA's Name

READ THE INSTRUCTIONS!

- **Write you name and student number clearly.** These exams will be scanned and names will be matched automatically. Also, write your name at the top of each page.
- Turn off and stow away all cell phones, pagers, radios, mp3 players, and other similar devices.
- This exam is closed book. You may use one $8.5'' \times 11''$ sheet of handwritten notes (both sides OK). Do not share notes. No photocopied or printed materials are allowed.
- Give your answers in exact form. For example, $\frac{\pi}{3}$ or $5\sqrt{3}$ are exact numbers while 1.047 and 8.66 are decimal approximations for the same numbers.
- You can only use a Texas Instruments TI-30X IIS calculator.
- In order to receive credit, you must **show all of your work**. If you do not indicate the way in which you solved a problem, you may get little or no credit for it, even if your answer is correct.
- Raise your hand if you have a question.
- This exam has 11 pages with 8 questions plus this cover page. The last page is left intentionally blank for overflow work. Please make sure that your exam is complete.

1. (12 total points) Answer the following.

(a) (4 points) Evaluate $\lim_{t \rightarrow 0} \left(\frac{1}{t\sqrt{4+t}} - \frac{1}{2t} \right)$

(b) (4 points) Evaluate $\lim_{x \rightarrow 0} \frac{1 - \cos x}{3 \sin^2 x}$

(c) (4 points) Use the *limit definition of the derivative* to find

$$\frac{d}{dx} \left(\frac{x}{x-3} \right)$$

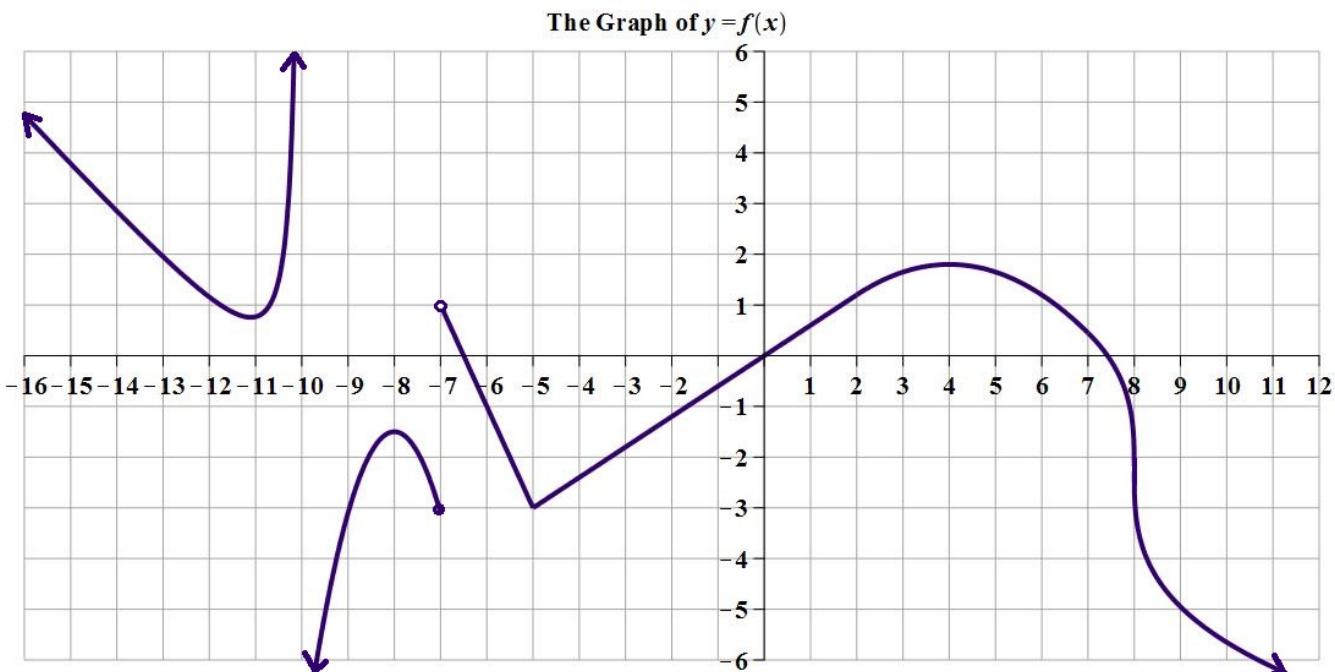
2. (12 total points) Find the derivatives of the following functions. You do not need to simplify your answers.

(a) (4 points) $f(x) = \frac{x^3 - x^2 + 1}{e^{3x-1}}$

(b) (4 points) $f(x) = \ln(\sin(\ln(x)))$

(c) (4 points) $f(x) = \sqrt{x^3} + 3^{\sqrt{x}} + 3(\sqrt{x})^{\sqrt{x}}$

3. (16 points) The function whose graph is shown below has domain all real numbers except $x = -10$ and the value $f(-7) = -3$. For limit questions your answer must be a number, $-\infty$, ∞ , or DNE. Make your best estimate in the case you cannot clearly read the numbers from the graph. You do not have to show your work.



(a) $\lim_{x \rightarrow -7} f(x) =$

(b) $\lim_{x \rightarrow -5} f(x) =$

(c) $\lim_{x \rightarrow -10^-} f(x) =$

(d) $\lim_{x \rightarrow 0} \frac{f(x)}{x} =$

(e) List all critical numbers of $f(x)$.

(f) List the intervals where $f'(x) > 0$.

(g) List the intervals where $f''(x) < 0$.

(h) $\lim_{h \rightarrow 0} \frac{f(-6+h) + 1}{h} =$

4. (11 points) The point $(1, 1)$ lies on the implicitly defined curve

$$x^4 + xy^2 = 2y^3.$$

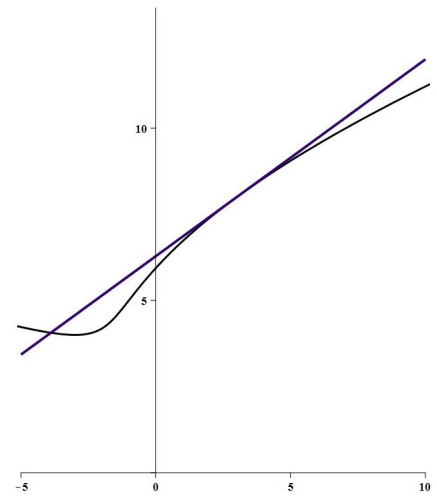
(a) Use linearization to approximate the coordinates (x, y) on the curve when $x = 1.01$.

(b) Is the approximation for y an over-estimate or an under-estimate? Justify your answer.

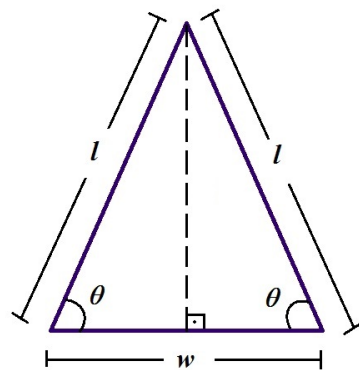
5. (10 points) In the picture shown, the line is tangent to the parametric curve

$$x = t^3 + 4t^2 + 7t + 3 \quad \text{and} \quad y = t^2 + 4t + 8$$

at the point $(3, 8)$. Find the coordinates of the point P , where the tangent line intersects the curve again.



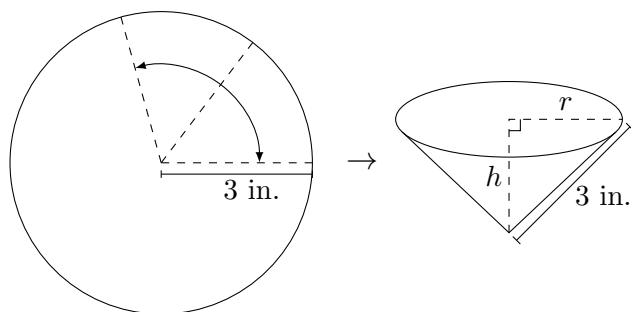
6. (12 points) Label the sides of an isosceles triangle as pictured. The side w is increasing at a rate of 3 ft/min while the sides ℓ are decreasing at a rate of 2 ft/min. Find how fast the angles shown are changing when $w = 10$ feet and $\theta = \frac{\pi}{4}$ radians.



7. (10 points) You have a circular sheet of paper, measuring 6 inches in diameter. From it, you want to make a conical drinking cup by folding together two radial lines of the circle. What is the maximum volume of a cone you can make in this way?

Recall that the volume of a cone of radius r and height h is $V = \frac{1}{3}\pi r^2 h$.

Make sure to justify that you have maximized the volume.

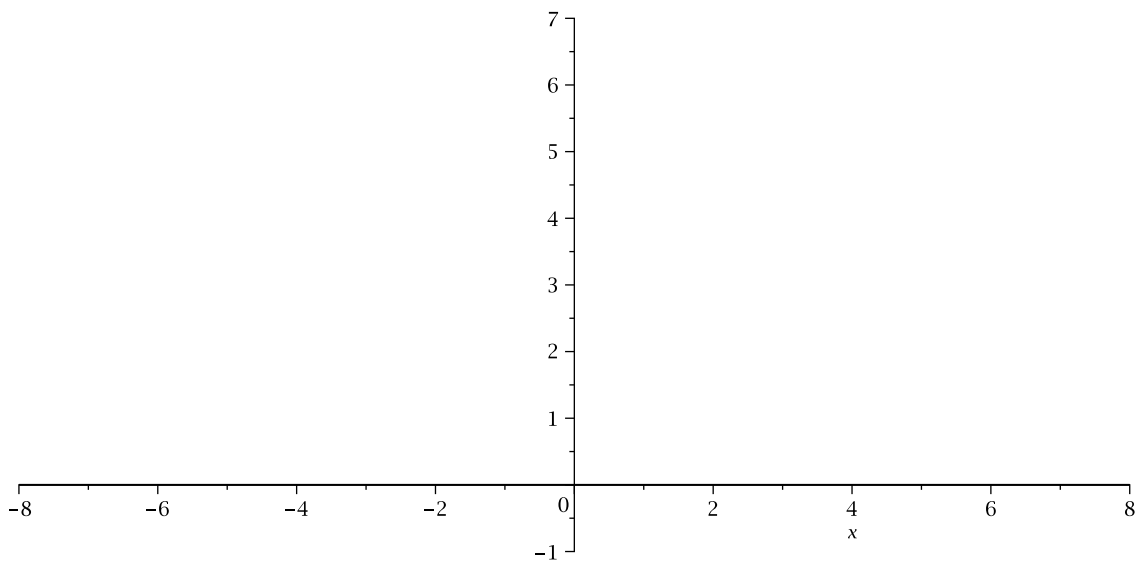


8. (17 total points) Consider the function $f(x) = 3 - \frac{12x}{x^2 + 3}$.
- (a) (3 points) Find the x and y intercepts of the graph of $y = f(x)$.
- (b) (3 points) Find the vertical and horizontal asymptotes, if any.
- (c) (4 points) Find the critical numbers for $f(x)$ and determine if each gives a local minimum, a local maximum, or neither.

Recall that the function is $f(x) = 3 - \frac{12x}{x^2 + 3}$.

- (d) (4 points) Find the inflection point(s) of $y = f(x)$. In which interval(s) is the graph concave down?

- (e) (3 points) Sketch the graph of $y = f(x)$ on the axes provided below. Mark the coordinates of any local maximum, local minimum or inflection points. Make sure your picture matches the information you provided in parts (a)-(d).



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