
On the front page please write your name and clearly label each problem This exam is worth 100 points and has 4 questions on both sides of this paper.

- Make sure all of your work is on separate sheets of paper. Nothing on this exam sheet will be graded. Please begin each problem on a new page.
 - **Show all work and simplify your answers!** Name any theorem that you use. Answers with no justification will receive no points unless the problem explicitly states otherwise.
 - Notes, papers, calculators, cell phones, and other electronic devices are not permitted, except for a computer for proctoring through Zoom.
 - You must use methods that we have learned in class thus far to solve the problems.
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- (10 pts) Short answer. If true, state why and if false, give a counterexample.
 - If the error in the radius of a circle is ± 0.1 m and the radius is 10 m, then the approximate error in its area is 2π m².
 - A value can be a critical point or a point of inflection but not both.
 - (24 pts) Find $\frac{dy}{dx}$ for the following equations.
 - $y = (x^2 + \sin(x^2))^7$
 - $y = \frac{\sqrt{4-x^2}}{x^2}$
 - $\cos(xy) + x^2y^2 = 1$
 - (10 pts) You're burning a log (idealized as a cylinder) on the fire. The fire evenly consumes the log such that the radius decreases by 3 inches every hour. Supposing that the log initially has a radius of 6 inches, how fast is the cross-sectional area of the log decreasing after the log has been on the fire for 40 minutes? Show all work.
 - (24 pts) The following questions are not related. Justify your answers and cite any theorems you use.
 - Approximate $\sqrt{8}$ using linearization.
 - Find the absolute maximum and minimum of $f(x) = x^3 + \frac{3}{2}x^2 - 6x + 1$ on the interval $[-2, 2]$.
 - (32 pts) Let $f(x) = \frac{x}{x^2 + 1}$.
 - Find all vertical and horizontal asymptotes. If none exist, state this.
 - Find the intervals of increase/decrease and critical points.
 - Find intervals of concavity and points of inflection. (You can use the fact that $f''(x) = \frac{2x(x^2-3)}{(x^2+1)^3}$ to save time)
 - Use this information to sketch the function.
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