# Math 1231 Final

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December 15-16, 2020

1. This test is due at the scheduled exam time. Logistically, this will work just like the mastery quizzes: download it, write up your answers, and upload them to Blackboard for us to grade.
2. You will have two hours for this test. Please write down your start and end times on the test and include that in your upload. You may not spend more than two hours on the test unless you have a specific accommodation.
3. You are not allowed to consult books or notes during the test, but you may use a one-page cheat sheet you have made for yourself ahead of time. Please upload your sheet along with your test.
4. If you have questions, I will be online and responsive during the scheduled exam time. If you want to take the test at a time you know I'll be able to answer any questions quickly, I encourage you to use that time slot.
5. You may use a calculator, but don't use a graphing calculator or anything else that can do symbolic computations. Using a calculator for basic arithmetic is fine.

**Name:**

**Time Started:**

**Time Completed:**

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**Problem 1.** (a) A curve is defined by the equation $x^4 - 2x^2y^2 + y^4 = 16$. Verify that the curve passes through the point $(\sqrt{5}, 1)$. What is the equation of the tangent line to the curve at this point?

(b) Find all the critical points of $g(x) = \dfrac{x^2 - 8}{x + 3}$

(c) Find the absolute extrema of $f(x) = 3x^4 - 20x^3 + 24x^2 + 7$ on $[0, 5]$.

**Problem 2.** (a) Classify the relative extrema of $h(x) = \sqrt[3]{x}(x+4)$

(b) Ten miles from home you remember that you left the water running, which is costing you 90 cents an hour. Driving home at speed $s$ miles per hour costs you $4(s/10)$ cents per mile. At what speed should you drive to minimize the total cost of gas and water?

**Problem 3.** (a) If $g(x) = \cos(x)$, use a quadratic approximation centered at 0 to estimate $g(.1)$.

(b) Use two iterations of Newton's Method starting at 2 to estimate $\sqrt[3]{7}$.

(c) Using four rectangles and right endpoints, approximate the area under the curve $\sqrt{x}$ between $x = 5$ and $x = 9$.

**Problem 4.** (a) Using **only the definition of Riemann sum** and your knowledge of limits, compute the exact area under the curve $x^2 + x^3$ between $x = 1$ and $x = 3$.

(b) Let $G(x) = \int_1^{x^2+1} t\sqrt{1-t^2}\,dt$. What is $G'(x)$?

(c) Compute $\displaystyle\int \sin^4(t)\cos(t)\,dt$

**Problem 5.** (a) **By explicitly changing the bounds of the integral**, compute $\int_0^4 x^3\sqrt{9+x^2}\,dx$.

(b) Find the area of the region bounded by $x - 2y = 0$ and $x = y^2 - 2y$.

(c) What is the average value of the function $h(x) = x^2 + x$ on the interval $[0, 6]$?