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. (Dominance of powers is not valid)

1. (20 pts) Unrelated, short answer questions.
   (a) Given $x_1 = 1$ and $f(x) = -x^3 - x^2 + 4$, find $x_2$ using Newton’s method.
   (b) Find $f$ (generalized anti-derivative):
      i. $f'(x) = x^{2/3} + \frac{1}{x^{3}} + \frac{1}{\sqrt{x}}$
      ii. $f''(\theta) = \theta + \sin(\theta) - \cos(\theta)$

2. (13 pts) A person standing on the edge of a cliff throws a ball upward at 10 m/s. The ball hits the ground below at 90 m/s. Assume that the ball experiences a constant acceleration of 10 m/s$^2$ downward. How tall is the cliff? Use anti-differentiation.

3. (22 pts) Let $f(x) = x^2 + x$ on the interval $[-1, 0]$.
   (a) Set up the Riemann sum for this function and the given interval. Use $n$ equally spaced subintervals and right endpoints.
   (b) Simplify the sum. (i.e. find a value that no longer has summations)
   (c) Using limit rules, evaluate the limit of the simplified sum as $n \to \infty$.
   (d) Compute using a definite integral.

4. (12 pts) Using the Fundamental Theorem of Calculus, find $f'(x)$ if
   \[ f(x) = \int_{\cos(x)}^{x^3} \frac{\sin(t)}{t} \, dt \]
5. (33 pts) Find the following:

(a) \[ \int \frac{x}{\sqrt{x^2 + 1}} \, dx \]

(b) \[ \int_0^{\pi/3} \frac{\sin(\theta)}{\cos^3(\theta)} \, d\theta \]

(c) The average value of \( f(t) = \frac{1}{t^2} + t \) on \([1, 3]\).

Formulas:
\[
\sum_{i=1}^{n} i = \frac{n(n+1)}{2} \quad \sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6} \quad \sum_{i=1}^{n} i^3 = \left[ \frac{n(n+1)}{2} \right]^2
\]