MATH-140
Spring 2026
Exam 3 Review
March 25, 2026

Name: _____

Pledge: _____

Each question topic and point value is recorded in the tables below. Note that this exam must be completed within the 50 minutes allotted during class. Also, you must work without any external resources (e.g., no notes or calculator). You must show an appropriate amount of work to justify your answer for each problem. If you run out of room for a given problem, you may continue your work on the back of the page. By writing your name and signing the pledge you are stating that you understand the rules outlining this exam.

Scoring Table

Question	Points	Score
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
Total:	60	

Topics Table

Question	Topic
1	Related Rates
2	Rolle's Theorem and the Mean Value Theorem
3	Curve Sketching: Domain, Intercepts, and Asymptotes
4	Curve Sketching: Increasing/Decreasing Behavior
5	Curve Sketching: Concavity and Graph
6	Optimization

1. A plane is flying at a constant height of 3000 ft above a fixed observation point. At a certain instant the angle of elevation from the observation point to the plane is $\arctan(3/4)$ radians and the speed of the plane is 500 ft/s.

   (a) (2 points) Draw a figure that illustrates the problem and identify variables for the angle of elevation and the distance from the observation point and the plane.

   (b) (4 points) How fast is the angle of elevation changing at this instant?

   (c) (4 points) How fast is the distance from the observation point and the plane changing at this instant?

2. (a) (2 points) State Rolle's Theorem.

(b) (2 points) State the Mean Value Theorem.

(c) (3 points) Sketch the graph of a function that satisfies the hypothesis of the Mean Value Theorem. Clearly label the point c guaranteed by the theorem.

(d) (3 points) Briefly explain, in geometric terms, what the Mean Value Theorem guarantees.

3. Consider the function

$$f(x) = \frac{x^2 + 5x + 4}{(x+2)^2}.$$

(a) (2 points) State the domain of $f(x)$.

(b) (2 points) Find the x and y intercepts of $f(x)$.

(c) (3 points) Find the vertical asymptotes of $f(x)$. Use limits to justify your answers.

(d) (3 points) Find the horizontal asymptotes of $f(x)$. Use limits to justify your answers.

4. Consider the function

$$f(x) = \frac{x^2 + 5x + 4}{(x+2)^2}.$$

(a) (4 points) Find all critical numbers of $f(x)$.

(b) (4 points) Determine the intervals on which $f(x)$ is increasing or decreasing.

(c) (2 points) Identify all local extrema of $f(x)$.

5. Consider the function

$$f(x) = \frac{x^2 + 5x + 4}{(x+2)^2}.$$

(a) (4 points) Find where $f''(x)$ is zero or undefined (potential inflection points).

(b) (4 points) Determine the intervals on which $f(x)$ is concave up or concave down.

(c) (2 points) Sketch the graph of $f(x)$.

6. A rectangle is inscribed in a semicircle of radius 6. Use the following steps to identify the dimensions of the rectangle of maximum area.

   (a) (2 points) Draw a picture of the problem and include problem variables.

   (b) (2 points) Write an optimization model for this problem.

   (c) (4 points) Solve the corresponding absolute extrema problem.

   (d) (2 points) Identify the dimensions of the rectangle of maximum area.