EXAM DATE/TIME: Thursday, December 6, 7:00 p.m. - 10:00 p.m.
Location announced by your professor

Definitions and Theorems to State:
- The (limit) definition of the derivative of \( f(x) \)
- The definition of continuity at \( x = a \)

Theorems to Use but not State (if you use one, say you are using it):
- The Extreme Value Theorem (Closed Interval Method)
- First derivative test for local extrema
- L’Hopital’s rule
- The relationship of continuity to differentiability
- Second derivative test for local extrema
- Fundamental Theorems of Calculus (Part 1 and Part 2)
- Intermediate Value Theorem

Properties you will be responsible for:
- Properties of logarithmic and exponential functions
- other precalculus-level formulas (in addition to those listed below)

Limits:
- Be able to find the limits and one-sided limits of functions (even if not continuous), both analytically and graphically
- Find limits that approach infinity or have an infinite limit
- Determine horizontal asymptotes and vertical asymptotes of a function; justify your answer using one or more limits
- Be able to use L’Hopital’s Rule to find limits (and identify and state the appropriate indeterminate forms that allow you to do so)
- Applications of continuity, including the Intermediate Value Theorem
- Verify continuity (analytically and graphically)
- Determine intervals on which a function is continuous
- Be able to “repair” a removable discontinuity by (re)defining the function at that \( x \)-value
- Determine the value of a parameter that makes a piecewise function continuous where the two pieces meet

Derivatives:
- Be able to find the derivative \( f'(x) \) from the definition
- Be able to use rules to find the derivative; know all rules from back of book through inverse trig function (no hyperbolic or parametric, no \( \arccsc(x) \), arccot \( (x) \), or \( \text{arccsc}(x) \))
- Implicit differentiation
- Be able to compute derivatives at specific points using limited information (e.g. a table)
- Be able to find an equation of the tangent line at a point
- Be able to understand/interpret the slope of a function
- Logarithmic differentiation

**Proof-based Problems:**
- Use differentiation of the appropriate inverse function to verify the differentiation rule for $\ln(x)$
- Use differentiation of the appropriate inverse function to verify the differentiation rule for $\arcsin(x)$, $\arccos(x)$, and $\arctan(x)$ (including an appropriate right triangle diagram or a Pythagorean identity)

**Applications of Derivatives**
- Applications involving a tangent line
- Be able to find and use the linearization
- Be able to find and use the differential
- Position, displacement, velocity, acceleration problems
- Applied rates of change other than position, velocity, and acceleration
- Related rates
- Understand the relationship between (first and second) derivatives and curve behavior; curve sketching from derivative information
- Determine all extrema of a function on a closed interval
- Applied optimization (open and/or closed interval); justify that you have a max or min

**Integration**
- Antiderivatives: most general antiderivative as well as initial value problems
- Understand the definite integral as (signed) area
- Apply properties of the definite integral
- Be able to use the definite integral to compute and interpret
  - signed area
  - total area
  - area between two curves
  - average value of a function
- Estimate a definite integral using well-chosen sums with a small number of rectangles (left, right, midpoint), and interpret your answer
- Express a right endpoint Riemann sum with $N$ rectangles of equal width in summation form, using only the summation symbol, $k$, $N$, and numbers
- Compute a definite integral:
  - by interpreting it as area
  - by Evaluation Theorem (FTC 2)
  - by integration via substitution

**Terminology to be familiar with (in addition to terminology listed in sections above):**
- average rate of change/ secant slope, average velocity
- instantaneous rate of change/ tangent slope
-average value of a function
-tangent lines and linearization of a function at a point
-domain
-critical points (critical numbers), inflection points
-increasing, decreasing, concave up, concave down
-local (relative) extrema
-absolute (relative) extrema

**Penalties (approximately 20% of problem’s points value for each issue):**
-Improper use of $+C$ or missing $+C$
-Improper use of limit notation
-Improper use of integral or sigma
-Improper use of “=” (like $y = \cos^2(x) = -2\cos(x)\sin(x)$)
-Improper algebraic notation (missing parentheses, incorrect variable name, etc.)

**Remarks for students:**
-Problems may combine multiple topics/techniques.
-You do not have to simplify your answers.
-Calculator **TI 30XS Multiview only**! No other calculators are allowed, and sharing of calculators is not allowed.
-Final answers are preferred in symbolic form (like $\sqrt{3}$ or $e^2$) but a final decimal approximation must be correct to 3 decimal places.
-You will leave your backpacks at the front of the room; a backpack that rings or buzzes will be taken out to the hallway and left there.
-No smart watches are allowed during the exam; your cell phone may not be on your person and must be stored in a backpack, purse, or other storage item left at the front of the classroom.
-No bathroom breaks unless you have a documented medical condition. Let your instructor know in advance.

**Formulas to Remember**
- Distance between $(x_1, y_1)$ and $(x_2, y_2)$: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- Triangles and Trig
  - perimeter (add up side lengths)
  - area: $A = \frac{1}{2}bh$
    - Be able to use properties of similar triangles.
  - Pythagorean Theorem for right triangles: $a^2 + b^2 = c^2$
  - right triangles and acute angle trig: SOH-CAH-TOA
  - $\tan(x) = \frac{\sin(x)}{\cos(x)}$  $\cot(x) = \frac{\cos(x)}{\sin(x)}$
  - $\csc(x) = \frac{1}{\sin(x)}$  $\sec(x) = \frac{1}{\cos(x)}$
  - $\sin^2(x) + \cos^2(x) = 1$
- Your trig differentiation formulas assume that your angle is in radians. (Why?)

- **Circles**
  - area: \( A = \pi r^2 \)
  - circumference: \( C = 2\pi r \)
  - Equation of the circle of radius \( r \) centered at \((h, k)\): \((x - h)^2 + (y - k)^2 = r^2\)

- **Rectangles**
  - area: \( A = lw \)
  - perimeter: \( P = 2l + 2w \)

- **Cylinder**
  - volume: \( V = \pi r^2 h \)
  - surface area: \( S = 2\pi r^2 + 2\pi rh \) (includes base and lid)

- **Rectangular prisms**
  - volume: \( V = lwh \)
  - surface area: \( S = 2lw + 2wh + 2lh \) (includes top and base)