

# Information

**Venue:** See instructor, not your regular classroom.

**Calculator:** TI 30XS MultiView exclusively

**Bring your UGA ID**

## What you should know

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### Definitions and Theorems to State:

- The definition of the derivative using limits for  $f(x)$ .
- The definition of continuity at  $x = a$ .

### Properties to Cite when Using:

- The relationship of continuity to differentiability.
- The Extreme Value Theorem (Closed Interval Method).
- First derivative test for local extrema.
- Second derivative test for local extrema.
- Second derivative criterion for concavity.
- L'Hopital's rule.
- Fundamental Theorems of Calculus (Part 1 and Part 2).

### 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 limits and one-sided limits of functions, even if they are not continuous, both analytically and graphically.
- Find limits that approach infinity or have an infinite limit.
- Determine horizontal and vertical asymptotes of a function, and justify your answer using one or more limits.
- Be able to use L'Hopital's Rule to find limits, and identify the indeterminate forms that allow you to do so.
- Verify continuity, analytically and graphically.

- Determine intervals on which a function is continuous.
- Be able to “repair” a removable discontinuity by redefining 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 limit definition of the derivative.
- Be able to use rules to find the derivative; know all rules from the back of the book through inverse trig functions, with no hyperbolic or parametric functions and no  $\operatorname{arcsec}(x)$ ,  $\operatorname{arccot}(x)$ , or  $\operatorname{arccsc}(x)$ .
- Implicit differentiation.
- Be able to compute derivatives at specific points using limited information, for example from a table.
- Be able to find an equation of the tangent line at a point.
- Be able to understand and 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, and acceleration problems.
- Interpret the derivative as a rate of change in a wide range of contexts.
- 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, on open and/or closed intervals; justify that you have a maximum or minimum.

#### **Integration:**

- Antiderivatives: find the most general antiderivative and solve initial value problems.
- Understand the definite integral as net area.
- Apply properties of the definite integral.
- Be able to use the definite integral to compute and interpret:
  - net area,

- total area,
- area between two curves.
- Estimate a definite integral using well-chosen sums with a small number of rectangles, such as left, right, and midpoint sums, and interpret your answer.
- Use summation notation to express a Riemann sum with  $N$  rectangles of equal width and right endpoints, using only the summation symbol,  $k$ ,  $N$ , and numbers.
- Compute a definite integral:
  - by interpreting it as area,
  - by the Evaluation Theorem, FTC Part 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,
- tangent lines and linearization of a function at a point,
- domain,
- critical points and critical numbers, inflection points,
- increasing, decreasing, concave up, concave down,
- local or relative extrema,
- absolute or global extrema.

**Penalties, approximately 20% of a problem's point value for each issue:**

- Improper use of  $+C$  or missing  $+C$ .
- Improper use of limit notation.
- Improper use of integral or sigma notation.
- Improper use of "=", for example writing  $y = x^3 = 3x^2$ .
- Improper algebraic notation, such as missing parentheses or incorrect variable names.

**Remarks for students:**

- Problems may combine multiple topics and techniques.
- You do not have to simplify your answers.
- Calculator: TI-30XS MultiView only. No other calculators are allowed, and sharing calculators is not allowed.
- You do not have to use a calculator; answers containing symbolic expressions such as  $\cos(7/3)$  and  $\ln(e^x)$  are acceptable. Include an exact answer for each problem.
- 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; smart devices, including smart watches and cell phones, 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.

## Formulas to Remember

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- 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,
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$$\begin{aligned} \tan(x) &= \frac{\sin(x)}{\cos(x)} & \cot(x) &= \frac{\cos(x)}{\sin(x)} \\ \csc(x) &= \frac{1}{\sin(x)} & \sec(x) &= \frac{1}{\cos(x)} \end{aligned}$$

- $\sin^2(x) + \cos^2(x) = 1$ ,
- your trig differentiation formulas assume that your angle is in radians.

- 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:  $S = 2\pi r^2 + 2\pi r h$ , including base and lid.

- Rectangular prisms:

- volume:  $V = lwh$ ,
- surface area:  $S = 2lw + 2wh + 2lh$ , including top and base.

- Circular cone:

- volume:  $V = \frac{1}{3}\pi r^2 h$ .

- Sphere:

- volume:  $V = \frac{4}{3}\pi r^3$ .