

Calculus

Limits & Continuity **LC**

Identify and Calculate Limits: Students determine the limit of a function at a value numerically, graphically, and analytically.

- 1 Identify vertical asymptotes in rational and logarithmic functions by identifying locations where the function value approaches infinity; estimate limits numerically and graphically; calculate limits analytically: **C.LC.1**
 - 1 Algebraic simplification **C.LC.1.1**
 - 2 Direct substitution **C.LC.1.2**
 - 3 One-sided limits **C.LC.1.3**
 - 4 Rationalization **C.LC.1.4**
 - 2 Calculate infinite limits and use the result to identify vertical asymptotes in rational and logarithmic functions. **C.LC.2**
 - 3 Calculate limits at infinity and use the result to identify horizontal asymptotes in rational and exponential functions. **C.LC.3**
 - 4 Calculate limits at infinity and use the result to identify unbounded behavior in rational, exponential, and logarithmic functions. **C.LC.4**
 - 5 Identify and classify graphically, algebraically, and numerically if a discontinuity is removable or nonremovable; identify the three conditions that must exist in order for a function to be continuous at $x = a$: **C.LC.5**
 - 1 $f(a)$ is defined **C.LC.5.1**
 - 2 The limit as x approaches a of $f(x)$ equals $f(a)$ **C.LC.5.2**
 - 3 The limit as x approaches a of $f(x)$ exists **C.LC.5.3**
 - 6 Apply the Intermediate Value Theorem for continuous functions. **C.LC.6**
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Derivatives **D**

Equation of a Tangent Line: Students use derivatives to solve problems both theoretically and in real-world context.

- 1 Approximate the derivative: **C.D.1**
 - 1 Graphically by finding the slope of a tangent line drawn to a curve at a given point. **C.D.1.1**
 - 2 Numerically by using the difference quotient. **C.D.1.2**
- 2 Find the equation of the tangent line using the definition of derivative. **C.D.2**
- 3 Establish and apply that differentiability implies continuity, but continuity does not necessarily imply differentiability. **C.D.3**

- 4 Compare the characteristic of graphs of f and f' : C.D.4
 - 1 Generate the graph of f given the graph of f' and vice versa. C.D.4.1
 - 2 Establish the relationship between the increasing and decreasing behavior of f and the sign of f' . C.D.4.2
 - 3 Identify maxima and minima as points where increasing and decreasing behavior change. C.D.4.3
- 5 Apply the Mean Value Theorem on a given interval. C.D.5
6. Compare the characteristic of graphs of f , f' , and f'' : C.D.6
 - 1 Generate the graphs of f and f' given the graph of f'' and vice versa. C.D.6.1
 - 2 Establish the relationship between the concavity of f and the sign of f'' . C.D.6.2
 - 3 Identify points of inflection as points where concavity changes. C.D.6.3
- 7 Find derivatives of functions using: C.D.7
 - 1 Power rule C.D.7.1
 - 2 Product rule C.D.7.2
 - 3 Quotient rule C.D.7.3
- 8 Find derivatives of: C.D.8
 - 1 An implicitly defined equation C.D.8.1
 - 2 Composite functions using chain rule C.D.8.2
 - 3 Exponential and logarithmic functions C.D.8.3
 - 4 Functions requiring the use of more than one differentiation rule C.D.8.4
- 9 Find the equation of: C.D.9
 - 1 A line tangent to the graph of a function at a point C.D.9.1
 - 2 A normal line to the graph of a function at a point C.D.9.2
- 10 Solve application problems involving: C.D.10
 - 1 Optimization C.D.10.1
 - 2 Related rates C.D.10.2
- 11 Interpret the derivative as a rate of change and varied applied contexts. C.D.11
 - 1 Contexts include: velocity, speed, and acceleration C.D.11.1

Integrals I

Define the Definite Integral: Students apply techniques of integration to solve problems, both theoretically and in contextual models that represent realworld phenomena.

- 1 Define the definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval. C.I.1
 - 1 If f is a real, continuous function defined on $[a, b]$ and F is an antiderivative of f in $[a, b]$, then $\int_a^b f(x)dx = F(b) - F(a)$ b a . C.I.1.1

- 2 Determine the area between two curves and identify the definite integral as the area of the region bounded by two curves. [C.I.2](#)
 - 3 Apply the Fundamental Theorem of Calculus to solve contextual models that represent real-world phenomena. [C.I.3](#)
 - 4 Find the general solution to indefinite integrals. [C.I.4](#)
 - 5 Determine the antiderivative of a function using rules of basic differentiation, and solve problems using the techniques of antidifferentiation including but not limited to power rule and u-substitution. [C.I.5](#)
 - 6 Estimate definite integrals by using Riemann sums (left, right, midpoint, and trapezoidal) and identify the definite integral as a limit of Riemann sums. [C.I.6](#)
 - 7 Explore applications of integration. [C.I.7](#)
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