Calculus AB – Advanced Placement G/T
Essential Curriculum

UNIT I: Analysis of Graphs

Goal. The student will demonstrate the ability to use a problem-solving approach in using technology to investigate graphical, geometric and numerical relationships between functions. The student should be able to communicate these relationships in both oral and written form.

Objectives - The student will be able to:

a. Use technology to produce graphs of functions in order to examine the interplay between the geometric and analytic information.
b. Use calculus to predict and explain the observed local and global behavior of a function.

UNIT II: Limits of Functions (including one-sided limits)

Goal. The student will demonstrate the ability to use a problem-solving approach in calculating limits algebraically and estimating limits from graphs and tables of values. The student should be able to communicate the relationships between their estimates and their algebraic results in both oral and written form

Objectives - The student will be able to:

a. Estimate limits from graphs and tables of values.
b. Calculate limits algebraically.

UNIT III: Asymptotic Behavior

Goal. The student will demonstrate the ability to use a problem-solving approach in finding relationships between graphical representations of asymptotes and the algebraic results of limit calculations. The student should be able to communicate these relationships in both oral and written form.

Objectives - The student will demonstrate the ability to:

a. Identify and make inferences about asymptotes in terms of graphical behavior.
b. Describe asymptotic behavior in terms of infinite limits and limits at infinity.
c. Compare and contrast relative magnitudes of functions and their rates of changes. (For example, contrast exponential growth, polynomial growth, and logarithmic growth.)

UNIT IV: Continuity as a Property of Functions

Goal. The student will demonstrate the ability to use a problem-solving approach to the properties of functions, in general, and how they relate to continuity in particular. The student should be able to communicate the resulting relationships in both oral and written form.

Objectives - The student will be able to:

a. Explain continuity in terms of limits.
b. Explain the Intermediate Value and Extreme Value Theorems in terms of the graphs of continuous functions.

UNIT V: Concept of the Derivative

Goal. The student will demonstrate the ability to use a problem-solving approach in defining the derivative of a function. The student should also be able to give geometric, numeric, graphic, and symbolic meaning to this definition in both oral and written form.

Objectives - The student will be able to:

a. Analyze the concept of the derivative of a function from geometric, numeric, graphic, and symbolic approaches.
b. Define the derivative of a function as the limit of the difference (Newton's) quotient.
c. Define the derivative as an instantaneous rate of change.
d. Explain the relationship between differentiability and continuity.

UNIT VI: Computing Derivatives

Goal. The student will demonstrate the ability to use a problem-solving approach in calculating derivatives of a variety of functions.

Objectives - The student will be able to:

a. Find the derivative of elementary functions, including power, exponential, logarithmic, trigonometric, and inverse trigonometric functions.
b. Find the derivative of the sum, product, and quotient of functions.
c. Find the derivative of trigonometric functions, composite functions using the Chain Rule, implicitly defined functions, and inverse functions.
d. Use logarithmic differentiation to algebraically differentiate a function with a variable exponent.

UNIT VII: The Derivative at a Point

Goal. The student will demonstrate the ability to use a problem-solving approach in applying the derivative to analytic methods. The student should be able to communicate the resulting relationships in both oral and written form.

Objectives - The student will be able to:

a. Find the slope of a curve at a point, including points where there are vertical or horizontal tangents, and points where there are no tangents.
b. Find an equation for a tangent to a curve at a point and local linear approximation.
c. Express the instantaneous rate of change of a function as the limit of the average rate of change.
d. Approximate rate of change from graphs and tables of values.

UNIT VIII: The Derivative as a Function

Goal. The student will demonstrate the ability to use a problem-solving approach in distinguishing relationships between f, f ', and f ' ', and how these relationships affect their graphs. The student should be able to communicate these relationships in both oral and written form.

Objectives - The student will be able to:

a. Distinguish corresponding characteristics of the graphs of f, f ', and f ' '.
b. Identify extrema, intervals of increasing or decreasing behavior, points of inflection, and concavity.
c. Use extrema, intervals of increasing/decreasing behavior, points of inflections, and concavity to sketch the graph or find the equation of the function.
d. Use the Mean Value Theorem and Rolle's Theorem to find the point in an interval at which the instantaneous rate of change equals the average rate of change.

UNIT IX: Applications of Derivatives

Goal. The student will demonstrate the ability to use a problem-solving approach in solving a variety of problems involving applications of the derivative.

Objectives - The student will be able to:

a. Solve problems involving such applications as the calculus of motion, including averages and extremes.
b. Solve optimization problems (absolute and relative extrema).
c. Model and solve rates of change problems (including related rates).
d. Identify indeterminate forms, and appropriately use L'Hopital's Rule to evaluate various limits.
e. Use implicit differentiation to find the derivative of an inverse function.
f. Interpret the derivative as a rate of change in a variety of applied contexts, including velocity, speed, and acceleration.

g. Geometrically interpret differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.
NOTE: This will begin with the administration of the 2003 - 2004 AP Exam.

UNIT X: Techniques of Antidifferentiation

Goal. The student will demonstrate the ability to use a problem-solving approach in finding antiderivatives using a variety of techniques.

Objectives - The student will be able to:

a. Find the antiderivatives, given the equation for the derivative of a function.
b. Find antiderivatives using substitution of variables, including change of limits for definite integrals and simple integration by parts.

UNIT XI: Applications of Antidifferentiation

Goal. The student will demonstrate the ability to use a problem-solving approach in applying antiderivatives to a variety of real-life situations. The student should be able to apply these procedures to the solving of variables-separable differential equations.

Objectives - The student will be able to:

a. Find specific antiderivatives given initial conditions, including applications of motion along a line.
b. Solve separable differential equations.
c. Find solutions to equations of the form y' = ky and solve problems involving its application to growth and decay.

UNIT XII: Properties of Definite Integrals

Goal. The student will demonstrate the ability to use a problem-solving approach in defining and applying the Fundamental Theorems of Calculus. The student should be able to the use numerical methods to approximate results of the Fundamental Theorem.

Objectives - The student will be able to:

a. Define the definite integral as a limit of Riemann sums over equal subintervals.
b. Define the integral of the rate of change of a quantity over an interval as the change of the quantity over the interval:

$$\int_a^b f'(x)\,dx = f(b) - f(a)$$

c. Apply the Fundamental Theorems of Calculus to a variety of functions to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined.
d. Compute Riemann sums using left, right, and midpoint evaluation points.
e. Use Riemann sums and the Trapezoidal Rule to find numerical approximations of definite integrals of functions, using left, right, and midpoint evaluation points.

UNIT XIII: Applications of Integrals

Goal. The student will demonstrate the ability to use a problem-solving approach to solve a variety of problems involving applications of the integral.

Objectives - The student will be able to:

a. Model a variety of problems from physical, social, and economic situations.
b. Use the integral in applications such as finding area, volume, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line.