Mathematics Department

Course: Calculus

Calculus is designed for juniors/seniors who have successfully completed Pre-Calculus and wish to begin the study of calculus prior to college without the pressure of an AP test at the end of the course. The course aims to provide both a thorough review of the properties, algebra, graphs, and language of all functions, followed by an introduction to the concepts and applications of calculus. Students will review all families of functions including those that are linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric, and piecewise defined. Students will apply limit theory and continuity to these functions and will begin an in-depth study of differentiation and integration techniques. Application of derivatives and integrals will be emphasized within their use in optimization, related rates, areas, and volumes of solids. Students will develop a solid background in the fundamentals of calculus so that they are prepared to further study the subject and related sciences in college. 82 Successful completion of this course will be measured through teacher-generated assessments, projects, and assignments. This course can be counted in partial fulfillment of the state-mandated fifteen (15) credits of mathematics.

Developed by: Jessica Mabel and College Board

Effective Fall 2023

Scope and Sequence

The Scope and Sequence for this course references an extensive review of Pre-Calculus concepts followed by selected components of the first eight units in the College Board AP Calculus Curriculum.

Month	Calculus
September	**Unit 1 - Prerequisites for Calculus** - Analyze linear functions in the algebraic, numerical, and graphical representations - Finding increments and slope - Finding additional values of a linear functions - Modeling a linear equation - Using Point Slope Form - Finding Equations and lines - Use the language, notation, and graphical representation of functions to express relationships between variable quantities - Determine if a relation is a function

	- Find the domain and range of functions - Graph functions in a coordinate planes - Determine if a function is even or odd - Graph, write, and evaluate piecewise-defined functions including absolute value - Composing Functions - Model exponential growth and decay functions - Recognize exponential growth and decay in algebraic, numerical, and graphical representation - Simplify expressions using exponent rules - Analyze functions and relations defined parametrically and know how to determine their graphs; in particular, you will be able to analyze inverse relations algebraically and graphically by switching parametrizations of x and y. - Find inverses of one to one functions and will be able analyze logarithmic functions algebraically, graphically, and numerically as inverses of exponential functions. - Determine if a function is one to one - Find inverse functions graphically and algebraically - Use properties of logarithms - Use logarithms to solve exponential equations algebraically
October	**Unit 2: Limits and Continuity** - Interpret and Express limits using correct notation - Estimate limits using numerical and graphical information - Use properties of limits including sum, difference, products, quotients, and composite functions - Interpret and express one sided limits - Use the Squeeze theorem to evaluate limits - Interpret estimate, and determine infinite limits and limits at infinity - Determine the end behavior of functions - Analyze functions to find intervals of continuity and points of discontinuity and to determine the applicability of the Intermediate Value Theorem - Define continuity at a point - Determine the different types of discontinuities - Find points of continuity and discontinuity - Find the sum, differences, products, quotients, and compositions of continuous functions - Use limits to determine instantaneous rates of change, slopes of tangent lines, and sensitivity to change
November	**Unit 3: Derivatives** - Compute the derivative of a function at x = a using both forms of the limit definition and explain its relationship to slope. - Use different ways of denoting the derivative of a function - Graph y = f(x) given the graph of y = f'(x) - Evaluate one sided derivatives - Analyze and discuss the differentiability of functions

	- Find where a function is not differentiable
	- Compute a numerical derivative
	- Apply the Intermediate Value Theorem for Derivatives
	- Apply the rules for differentiation
	  - Power Rule
	  - Sum and difference rules
	  - Product and quotient rules
	  - Negative integer powers of x
	  - Second and higher order derivatives

Decembert	**Unit 3: Derivatives (Cont)** - Interpret the derivative as representing velocity and other rates of change - Find the displacement, velocity, and acceleration given the position function - Read and analyze a velocity graph - Model vertical motion and particle motion - Use derivatives as a measure of sensitivity to change - Use derivatives as a marginal cost and marginal revenue - Determine the derivatives of trigonometric functions - Model harmonic motion - Determine the jerk as the derivative of acceleration - Determine the tangent and normal lines of trigonometric functions
January	**Unit 4: More Derivatives** - Differentiate composite functions and parametrically defined functions using the Chain rule - Use the chain rule for differentiating a composite function - Use the chain rule to show how degree measure affects the calculus of trig functions - Find derivatives of implicitly defined functions and thereby analyze parametrically defined curves - Use the chain rule to find derivatives of functions defined implicitly - Find the tangent and normal lines to implicitly defined curves - Find higher order derivatives of implicitly defined functions - Use implicit differentiation to find the derivatives of inverses of functions with known derivatives - Find the derivatives of the inverse trigonometric functions - Find derivatives of exponential functions and logarithmic functions
February	**Unit 5: Applications of Derivatives** - Find the maximum or minimum value of a function over a given interval and determine the applicability of the Extreme Value Theorem - Use derivatives to find extrema - Apply the Mean Value Theorem to describe the behavior of a function over and

	interval - Determine intervals of increasing and decreasing - Use derivatives to analyze properties of a function - Use the first and second derivative tests for local extrema - Use the second derivative to find intervals of upward or downward concavity - Find points of inflection - Identify the key functions of functions and their derivatives
March	**Unit 5: Applications of Derivatives (Cont)** - Use derivatives to solve optimization problems - Develop a mathematical model - Analysis the function used to model the situation - Identify the critical points and endpoints - Identify and interpret the solution of an optimization problem - Solve problems involving the slope of the tangent line including linear approximation and differentials - Solve problems involving rates of change in applied contexts - Create an equation that relates the variable whose rate of change is known to the variable whose rate of change is sought - Use the chain rule to relate the rates of change - Identify and Interpret the solution of a related rates problem
April	**Unit 6: The Definite Integral** - Estimate distance, areas, volumes, and accumulations using finite sums - Calculate distance and accumulation as area under the velocity curve - Estimate the area under a curve using rectangular approximation - Estimate the volume using slices - Use left, right, and midpoint sums to approximate areas - Interpret the definite integral as the limit of a Riemann sum and express the limit of a Reimann sum in integral notation - Calculate definite integrals using areas - Use integral notation - Calculate a definite integral using areas and properties of definite integrals and apply definite integrals to problems involving the average value of a function - Analyze functions defined by an integral and evaluate definite integrals - Apply the Antiderivative part of the fundamental theorem of calculus - Find area using antiderivatives - Analyze antiderivatives graphically - Approximate definite integrals using the Trapezoidal Rule
May	**Unit 7: Differential Equations and Mathematical Modeling** - Use the slope fields to analyze solution curves to differential equations, and use Euler's method to construct solutions numerically

	- Find antiderivatives of functions to reverse the effect of the chain rule in differentiation - Calculate definite integrals - Use properties of indefinite integrals - Use substitution to evaluate indefinite and definite integrals - Solve separable differential equations, including those arising in problems of exponential growth, exponential decay, and logistic growth **Unit 8: Applications of Definite Integrals** - Apply the definite integral to problems involving motion and use the definite integral to solve problems involving accumulation - Find displacement as integral of velocity - Find total distance as integral of absolute value of velocity - Find net change given graphical representations of rate of change
June	**Unit 8: Applications of Definite Integrals (Cont)** - Apply the definite integral to solve problems involving areas - Find the areas between two curves - Find areas for which integration is with respect to y - Apply the definite integral to solve problems involving volumes - Find volumes with circular, square, or other cross sections - Find volumes of solids of revolution using washers or cylindrical shells **Final Review**