MIDLAND ISD
ADVANCED PLACEMENT CURRICULUM STANDARDS

	AP CALCULUS BC	
TEKS	**COLLEGE BOARD**	**COLLEGE AND CAREER READINESS STDS**
	Curricular Requirement 1: **The course teaches all topics associated with Functions, Graphs, and Limits; Derivatives; Integrals; and Polynomial Approximations and Series as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description.** **Scoring Component 1:** The course teaches all topics associated with Functions, Graphs, and Limits as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description. **A. Analysis of graphs** **B. Limits of functions (including one-sided limits)** **1.** An intuitive understanding of the limiting process. **2.** Calculating limits using algebra. **3.** Estimating limits from graphs or tables of data. **C. Asymptotic and unbounded behavior** **1.** Understanding asymptotes in terms of graphical behavior. **2.** Describing asymptotic behavior in terms of limits involving infinity. **3.** Comparing relative magnitudes of functions and their rates of change (for example, contrasting exponential growth, polynomial growth and logarithmic growth).	**I. Numeric Reasoning** **A. Number representation** **1.** Compare real numbers. **2**. Define and give examples of complex numbers. **B. Number operations** **1.** Perform computations with real and complex numbers. **C. Number sense and number concepts** **1.** Use estimation to check for errors and reasonableness of solutions. **II. Algebraic Reasoning** **A. Expressions and equations** **1.** Explain and differentiate between expressions and equations using words such as “solve,” “evaluate,” and “simplify.” **B. Manipulating expressions** **1.** Recognize and use algebraic (field) properties concepts, procedures, and algorithms to combine, transform, and evaluate expressions (e.g., polynomials, radicals, rational expressions). **C. Solving equations, inequalities, and systems of equations** **1.** Recognize and use algebraic (field) properties concepts, procedures, and algorithms to solve equations, inequalities, and systems of linear equations. **2.** Explain the difference between the solution

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	D. Continuity as a property of functions **1.** An intuitive understanding of continuity. (The function values can be made as close as desired by taking sufficiently close values of the domain). **2.** Understanding continuity in terms of limits. **3.** Geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem). **E. Parametric, polar and vector functions** **1.** The analysis of planar curves includes those given in parametric form, polar form and vector form. **Scoring Component 2:** The course teaches all topics associated with Derivatives as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description. **A. Concepts of the derivative** **1.** Derivative presented graphically, numerically, and analytically. **2.** Derivative interpreted as an instantaneous rate of change. **3.** Derivative defined as the limit of the difference quotient. **4.** Relationship between differentiability and continuity.	set of an equation and the solution set of an inequality. **D. Representations** **1.** Interpret multiple representations of equations and relationships. **2.** Translate among multiple representations of equations and relationships. **III. Geometric Reasoning** **A. Figures and their properties** **1.** Identify and represent the features of plane and space figures. **2.** Make, test, and use conjectures about one-,two-,and three-dimensional figures and their properties. **3.** Recognize and apply right triangle relationships including basic trigonometry. **B. Transformations and symmetry** **1**. Identify and apply transformations to figures. **2.** Identify the symmetries of a plane figure. **3**. Use congruence transformations and dilations to investigate congruence, similarity, and symmetries of plane figures. **C. Connections between geometry and other mathematical content strands** **1.** Make connections between geometry and algebra. **2**. Make connections between geometry, statistics, and probability.

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	B. Derivative at a point **1.** Slope of a curve at a point. Examples are emphasized, including points at which there are vertical tangents and points at which there are no tangents. **2.** Tangent line to a curve at a point and local linear approximation. **3.** Instantaneous rate of change as the limit of average rate of change. **4.** Approximate rate of change from graphs and tables of values. **C. Derivative as a function** **1.** Corresponding characteristics of graphs of f and f'. **2.** Relationship between the increasing and decreasing behavior of f and the sign of f'. **3.** The Mean Value Theorem and its geometric interpretation. **4.** Equations involving derivatives. Verbal descriptions are translated into equations involving derivatives and vice versa. **D. Second derivatives** **1.** Corresponding characteristics of the graphs of f, f' and f''. **2.** Relationship between the concavity of f and the sign of f''.	**3.** Make connections between geometry and measurement. **D. Logic and reasoning in geometry** **1.** Make and validate geometric conjectures. **2.** Understand that Euclidean geometry is an axiomatic system. **IV. Measurement Reasoning** **A. Measurement involving physical and natural attributes** **1**. Select or use the appropriate type of unit for the attribute being measured. **B. Systems of measurement** **1.** Convert from one measurement system to another. **2.** Convert within a single measurement system. **C. Measurement involving geometry and algebra** **1.** Find the perimeter and area of two-dimensional figures. **2.** Determine the surface area and volume of three-dimensional figures. **3.** Determine indirect measurements of figures using scale drawings, similar figures, the Pythagorean Theorem, and basic trigonometry. **D. Measurement involving statistics and probability** **1**. Compute and use measures of center and spread to describe data. **2.** Apply probabilistic measures to practical

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	3. Points of inflection as places where concavity changes. **E. Applications of derivatives** **1.** Analysis of curves, including the notions of monotonicity and concavity. **2.** Analysis of planar curves given in parametric form, polar form and vector form, including velocity and acceleration. **3.** Optimization, both absolute (global) and relative (local) extrema. **4.** Modeling rates of change, including related rates problems. **5.** Use of implicit differentiation to find the derivative of an inverse function. **6.** Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration. **7.** Geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations. **8.** Numerical solution of differential equations using Euler's method. **9.** L'Hospital's Rule, including its use in determining limits and convergence of improper integrals and series.	situations to make an informed decision. **V. Probabilistic Reasoning** **A. Counting principles** **1.** Determine the nature and the number of elements in a finite sample space. **B. Computation and interpretation of probabilities** **1.** Compute and interpret the probability of an event and its complement. **2.** Compute and interpret the probability of conditional and compound events. **VI. Statistical Reasoning** **A. Data collection** **1**. Plan a study. **B. Describe data** **1**. Determine types of data. **2.** Select and apply appropriate visual representations of data. **3.** Compute and describe summary statistics of data. **4.** Describe patterns and departure from patterns in a set of data. **C. Read, analyze, interpret, and draw conclusions from data** **1.** Make predictions and draw inferences using summary statistics. **2.** Analyze data sets using graphs and summary statistics.

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	F. Computation of derivatives **1.** Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric and inverse trigonometric functions. **2.** Derivative rules for sums, products and quotients of functions. **3.** Chain rule and implicit differentiation. **4.** Derivatives of parametric, polar and vector functions. **Scoring Component 3:** The course teaches all topics associated with Integrals as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description. **A. Interpretations and properties of definite integrals** **1.** Definite integral as a limit of Riemann sums. **2.** Definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval: $\int_a^b f'(x)\,dx = f(b) - f(a)$ **3.** Basic properties of definite integrals (examples include additivity and linearity). **B. Applications of integrals**	**3.** Analyze relationships between paired data using spreadsheets, graphing calculators, or statistical software. **4.** Recognize reliability of statistical results. **VII. Functions** **A. Recognition and representation of functions** **1.** Recognize whether a relation is a function. **2.** Recognize and distinguish between different types of functions. **B. Analysis of functions** **1.** Understand and analyze features of a function. **2.** Algebraically construct and analyze new functions. **C. Model real world situations with functions** **1.** Apply known function models. **2.** Develop a function to model a situation. **VIII. Problem Solving and Reasoning** **A. Mathematical problem solving** **1**. Analyze given information. **2**. Formulate a plan or strategy. **3.** Determine a solution. **4**. Justify the solution. **5.** Evaluate the problem-solving process. **B. Logical reasoning** **1.** Develop and evaluate convincing arguments. **2**. Use various types of reasoning.

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	1. Appropriate integrals are used in a variety of applications to model physical, biological or economic situations. **2.** Although only a sampling of applications can be included in any specific course, students should be able to adapt their knowledge and techniques to solve other similar application problems. **3.** Whatever applications are chosen, the emphasis is on using the method of setting up an approximating Riemann sum and representing its limit as a definite integral. **4.** To produce a common foundation, specific applications should include finding: **a.** the area of a region, (including a region bounded by polar curves), **b.** the volume of a solid with known cross sections, **c.** the average value of a function, **d.** the distance traveled by a particle along a line, **e.** the length of a curve (including a curve given in parametric form), and	**C. Real world problem solving** **1.** Formulate a solution to a real world situation based on the solution to a mathematical problem. **2.** Use a function to model a real world situation. **3.** Evaluate the problem-solving process. **IX. Communication and Representation** **A. Language, terms, and symbols of mathematics** **1.** Use mathematical symbols, terminology, and notation to represent given and unknown information in a problem. **2.** Use mathematical language to represent and communicate the mathematical concepts in a problem. **3**. Use mathematics as a language for reasoning, problem solving, making connections, and generalizing. **B. Interpretation of mathematical work** **1.** Model and interpret mathematical ideas and concepts using multiple representations. **2.** Summarize and interpret mathematical information provided orally, visually, or in written form within the given context. **C. Presentation and representation of mathematical work** **1.** Communicate mathematical ideas, reasoning, and their implications using symbols, diagrams,

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	f. accumulated change from a rate of change. **C. Fundamental Theorem of Calculus** **1.** Use of the Fundamental Theorem to evaluate definite integrals. **2.** Use of the fundamental Theorem to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined. **D. Techniques of antidifferentiation** **1.** Antiderivatives following directly from derivatives of basic functions. **2.** Antiderivatives by substitutions of variables (including change of limits for definite integrals), parts, and simple partial fractions (nonrepeating linear factors only). **3.** Improper integrals (as limits of definite integrals). **E Applications of antidifferentiation** **1.** Finding specific antiderivatives using initial conditions, including applications to motion along a line. **2.** Solving separable differential equations and using them in modeling (including the study of the equation $y' = ky$ and exponential growth). **3.** Solving logistic differential equations and using them in modeling.	graphs, and words. **2.** Create and use representations to organize, record, and communicate mathematical ideas. **3.** Explain, display or justify mathematical ideas and arguments using precise mathematical language in written or oral communication. **X. Connections** **A. Connections among the strands of mathematics** **1.** Connect and use multiple strands of mathematics in situations and problems. **2.** Connect mathematics to the study of other disciplines. **B. Connections of mathematics to nature, real world situations, and everyday life** **1.** Use multiple representations to demonstrate links between mathematical and real world situations. **2.** Understand and use appropriate mathematical models in the natural, physical, and social sciences. **3.** Know and understand the use of mathematics in a variety of careers and professions.

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	F. Numerical approximations to definite integrals **1.** Use of Riemann sums (using left, right, and midpoint evaluation points) and trapezoidal sums to approximate definite integrals of functions represented algebraically, graphically and by tables of values. **Scoring Component 4:** The course teaches all topics associated with Polynomial Approximation as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description. **A. Concept of series** **1.** A series is defined as a sequence of partial sums, and convergence is defined in terms of the limit of the sequence of partial sums. **2.** Technology can be used to explore convergence and divergence. **B. Series of constants** **1.** Motivating examples, including decimal expansion. **2.** Geometric series with applications. **3.** The harmonic series. **4.** Alternating series with error bound. **5.** Terms of series as areas of rectangles and their relationship to improper integrals, including the integral test	

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	and its use in testing the convergence of *p*-series. **6.** The ratio test for convergence and divergence. **7.** Comparing series to test for convergence or divergence. **C. Taylor series** **1.** Taylor polynomial approximation with graphical demonstration of convergence (for example, viewing graphs of various Taylor polynomials of the sine function approximating the sine curve). **2.** Maclaurin series and the general Taylor series centered at $x = a$. **3.** Maclaurin series for the functions e^x, $\sin x$, $\cos x$ and $\frac{1}{1-x}$. **4.** Formal manipulation of Taylor series and shortcuts to computing Taylor series, including substitution, differentiation, antidifferentiation and the formation of new series from known series. **5.** Functions defined by power series. **6.** Radius and interval of convergence of power series. **7.** Language error bound for Taylor polynomials.	

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	Curricular Requirement 2: **The course provides students with the opportunity to work with functions represented in a variety of ways – graphically, numerically, analytically, and verbally – and emphasizes the connections among these representations.** **Scoring Component 5: The course provides students the opportunity to work with functions represented graphically.** **Scoring Component 6:** The course provides students the opportunity to work with functions represented numerically. **Scoring Component 7:** The course provides students the opportunity to work with functions represented analytically. **Scoring Component 8:** The course provides students the opportunity to work with functions represented verbally. **Curricular Requirement 3:** **The course teaches students how to communicate mathematics and explain solutions to problems both verbally and in written sentences.** **Scoring Component 9:** The course teaches students how to explain solutions to problems orally. **Scoring Component 10:** The course teaches	

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	students how to explain solutions to problems in written sentences. **Curricular Requirement 4:** **The course teaches students how to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.** **Scoring Component 11:** The course teaches students how to use graphing calculators to help solve problems. **Scoring Component 12:** The course teaches students how to use graphing calculators to experiment. **Scoring Component 13:** The course teaches students how to use graphing calculators to interpret results and support conclusions.	