Ganado Unified School District
AP Calculus AB

PACING Guide SY 2021-22 ***R. Berkey***

Timeline & Resources	AP-Calculus-Mathematics-Standards	Essential Questions HESS Matrix	Learning Goal	Vocabulary Content/Academic
Textbook Finney, Demana, Waits, Kennedy, and Bressoud. Calculus—Graphical, Numerical, Algebraic. 5rd ed. Pearson Prentice Hall, Boston, MA, 2016. Based on: AP-Calculus-AB-BC-course-and-exam-description at https://bit.ly/3bHq6km Kahn Academy Delta Math	**Standards for Mathematical Practices** 1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning. ***-will be applied in all units of study*** **1 Implementing Mathematical Processes- Determine expressions and values using mathematical procedures and rules** *1.a-Identify the question to be answered or*			

	problem to be solved (not assessed). *1.b-Identify key and relevant information to answer a question or solve a problem (not assessed)* *1.c-Identify an appropriate mathematical rule or procedure based on the classification of a given expression (e.g., Use the chain rule to find the derivative of a composite function).* *1.d-Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems.* *1.e-Apply appropriate mathematical rules or procedures, with and without technology* *1.f-Explain how an approximated value relates to the actual value.* **2-Connecting Representations-Translate mathematical information from a single representation or across multiple representations.** *2.a-Identify common underlying structures in problems involving different contextual situations.* *2.b-Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.* *2.c-Identify a re-expression of mathematical information presented in a given representation.*			

	2.d-Identify how mathematical characteristics or properties of functions are related in different representations *2.e-Describe the relationships among different representations of functions and their derivatives.* **3-Justification-Justify reasoning and solutions.** *3.a-Apply technology to develop claims and conjectures (not assessed).* *3.b-Identify an appropriate mathematical definition, theorem, or test to apply* *3.c-Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied* *3.d-Apply an appropriate mathematical definition, theorem, or test.* *3.e-Provide reasons or rationales for solutions and conclusions* *3.f-Explain the meaning of mathematical solutions in context* *3.g-Confirm that solutions are accurate and appropriate.* **4-Communication and Notation-Use correct notation, language, and mathematical conventions to communicate results or solutions.** *4.a-Use precise mathematical language* *4.b-Use appropriate units of measure.* *4.c-Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f'(x), y', dy/dx)* *4.d-Use appropriate graphing techniques.* *4.e-Apply appropriate rounding procedures.*			

	BIG IDEA 1: CHANGE (CHA) *Using derivatives to describe rates of change of one variable with respect to another or using definite integrals to describe the net change in one variable over an interval of another allows students to understand change in a variety of contexts. It is critical that students grasp the relationship between integration and differentiation as expressed in the Fundamental Theorem of Calculus—a central idea in AP Calculus.* **BIG IDEA 2: LIMITS (LIM)** *Beginning with a discrete model and then considering the consequences of a limiting case allows us to model real-world behavior and to discover and understand important ideas, definitions, formulas, and theorems in calculus: for example, continuity, differentiation, integration.* **BIG IDEA 3: ANALYSIS OF FUNCTIONS (FUN)** *Calculus allows us to analyze the behaviors of functions by relating limits to differentiation, integration, and infinite series and relating each of these concepts to the others.*			
Unit 0- prerequisites for calculus ~10 days			0.1 linear functions 0.2 functions and graphs 0.3 exponential functions ~~0.4 parametric functions(Bc)~~ 0.5 inverse functions and logarithms 0.6 trigonometric functions 0.7 rational functions	
Unit 1-Limits and Continuity			1.1 Introducing Calculus: Can Change Occur at an Instant?	Unit 1

~23 days			1.2 Defining Limits and Using Limit Notation 1.3 Estimating Limit Values from Graphs 1.4 Estimating Limit Values from Tables 1.5 Determining Limits Using Algebraic Properties of Limits 1.6 Determining Limits Using Algebraic Manipulation 1.7 Selecting Procedures for Determining Limits 1.8 Determining Limits Using the Squeeze Theorem 1.9 Connecting Multiple Representations of Limits 1.10 Exploring Types of 3 Discontinuities 1.11 Defining Continuity at a point 1.12 Confirming Continuity over an Interval 1.13 Removing 1Discontinuities 1.14 Connecting infinite limits and vertical asymptotes 1.15 Connecting infinite limits and Horizontal asymptotes 1.16 Working with the Intermediate Value Theorem (IVT)	Key Ideas Average and Instantaneous Speed Definition of limit Properties of limits One-sided and Two-sided limits Squeeze Finite limits as x >> +/- infinity Squeeze Theorem Revisited End Behavior Models "Seeing Limits" as x >>> +/- infinity Continuity as a point Continuous function Algebraic combinations Composites Intermediate value theorem for continuous functions Average Rates of Change Tangent to a Curve Slope of a Curve Speed Revisited

				Normal to a Curve Speed revisited Sensitivity
Unit-2- Differentiation: Definition and Basic Derivative Rules ~14 days			2.1 Defining Average and Instantaneous Rates of Change at a Point 2.2 Defining the Derivative of a Function and Using Derivative Notation 2.3 Estimating Derivatives of a Function at a Point 2.4 Connecting Differentiability and continuity: determining when derivative do & don't exist. 2.5 Applying the Power Rule 2.6 Derivative Rules: Constant, Sum, Difference, and constant Multiple 2.7 Derivatives of cos x, sin x, e^x , and ln(x) 2.8 The Product Rule 2.9 The Quotient Rule	Unit 2 Definition of Derivative Notation Relationship between the graphs of ***f*** and ***f'*** Graphing the derivative from data One-sided Derivatives How f'(a) might fail to exist Differentiation implies local linearity Numerical derivatives on a calculator Differentiability implies continuity Intermediate value theorem for derivatives Positive integer Powers, multiples, sums and differences Products and quotients

				Negative Integer powers of x Second higher order derivatives Instantaneous rates of change Motion along a line Sensitivity to change Derivatives in Economics Derivative of the sine function Derivative of the cosine function Simple harmonic motion Jerk Derivatives of the other basic trigonometric functions
Unit-3- Differentiation: Composite, Implicit, and Inverse Functions ~11 days			3.1 The Chain Rule 3.2 Implicit Differentiation 3.3 Differentiating Inverse Functions 3.4 Differentiating Inverse Trigonometric Functions 3.5 Selecting Procedures for Calculating Derivatives 3.6 Calculating Higher Order Derivatives	Unit 3 Derivatives of a composite function "Outside-inside" rule Repeated use of the Chain Rule Power Chain Rule Slopes of Parametrized Curves Power Chain Rule

				Implicitly Distinct Function Lenses, Tangents and Normal Lines Derivatives of the Higher Order Rational Powers Of Differentiable Functions Derivatives of Inverse Functions Derivatives of Arcsine Derivatives of Arctangent Derivatives of Arcsecant Derivatives of The Other Three Derivative of **e’** Derivative of **a’** Derivative of **ln x** Derivative of log,x Power Rule for arbitrary real powers
Unit-4- Contextual Applications of Differentiation ~11 Days			4.1 Interpreting the Meaning of the Derivative in Context 1 CHA 4.2 Straight-Line Motion: Connecting Position, Velocity, and Acceleration 1 CHA	Unit 4 Absolute/Global Extreme Values Local/Relative

			4.3 Rates of Change in Applied Contexts Other Than Motion 4.4 Introduction to Related Rates 4.5 Solving Related Rates Problems 4.6 Approximating Values of a Function Using Local Linearity and Linearization 4.7 Using L'Hospital's Rule for Determining Limits of Indeterminate Forms	Extreme Values Finding extreme Values Mean Value Theorem Physical Interpretation Of the Mean Value Theorem Increasing and Decreasing Function Order Consequences First Derivative Test for Local Extreme Concavity Points of Inflection Second Derivative Test for local extremes Learning about functions from derivatives A strategy for optimization Examples from business and industry Examples from economics

				Modeling discrete phenomena with differentiable functions Linear approximations Differentials Sensitivity analysis Absolute, relative, and percentage of change Newton's Method Newton's method may fail Related rate equations Solution strategy Simulating related motion Related rate equations Solutions strategy Stimulating related motions
Unit-5- Analytical Applications of Differentiation ~16 days			5.1 Using the Mean Value Theorem 5.2 Extreme Value Theorem, Global Versus Local Extrema, and Critical Points 5.3 Determining Intervals on Which a Function Is Increasing or Decreasing 5.4 Using the First Derivative Test to Determine Relative (Local) Extrema 5.5 Using the Candidates Test to Determine Absolute (Global) Extrema	

			5.6 Determining Concavity of Functions over Their Domains 5.7 Using the Second Derivative Test to Determine Extrema 5.8 Sketching Graphs of Functions and Their Derivatives 5.9 Connecting a Function, Its First Derivative, and Its Second Derivative 5.10 Introduction to Optimization Problems. 5.11 Solving Optimization problems. 5.12 Exploring Behaviors of Implicit Relations	
Unit-6- Integration and Accumulation of Change **~20 Days**			6.1 Exploring Accumulations of Change 6.2 Approximating Areas with Riemann Sums 6.3 Riemann Sums, Summation Notation, and Definite Integral Notation 6.4 The Fundamental Theorem of Calculus and Accumulation Functions 6.5 Interpreting the Behavior of Accumulation Functions Involving Area 6.6 Applying Properties of 3 Definite Integrals 6.7 The Fundamental Theorem of Calculus and Definite Integrals 6.8 Finding Antiderivatives and Indefinite Integrals: Basic Rules and Notation 6.9 Integrating Using Substitution 6.10 Integrating Functions Using Long Division and Completing the Square 6.14 Selecting Techniques 1 for Antidifferentiation	Unit 6 Accumulator function Area under a curve Average value Bounded function Cardiac output Characteristic function of the rationals Definite integral Differential calculus Dummy variables Error bounds Fundamental Theorem of Calculus Antiderivatives Fundamental Theorem of calculus Evaluation Part Integral function Integral calculus

				Integral Evaluation Theorem Integral of f from a to b Integral sign Integral Lower bound Lower limit of integration LRAM Mean value Mean value Theorem For definite integrals MRAM Net area NINT Norm of the partition Partition Rectangular Approximation Method (RAM) Regular partition Riemann sum BRAM Sigma notation Simpsons rule Subinterval Total area Trapezoidal Rule Upper bound Upper limit of integration Variable of integration

Unit-7- Differential Equations **~9 Days**			7.1 Modeling Situations with Differential Equations 2 FUN 7.2 Verifying Solutions for Differential Equations 7.3 Sketching Slope Fields 7.4 Reasoning Using Slope Fields 7.6 Finding General Solutions Using Separation of Variables 7.7 Finding Particular Solutions Using Initial Conditions and Separation of Variables 7.8 Exponential Models with Differential Equations	Unit 7 Antidifferen-tiation by parts Antidifferen-tiation by substitution Carbon-14 dating Carrying capacity Compounded continuously Constant of integration Continuous interest rate Differential equation Euler's method Evaluate an integral Exact differential equation Exponential decay constant Exponential growth constant First-order differential First-order linear differential equation General solution to a differential equation

				Graphical solution of a differential equation Half-life Heavy –side method Indefinite integral Initial condition Initial value problem Integral sign Integrand Integration by parts Law of Exponential Change Leibniz Notation for integrals Logistic curve Logistic differential equation Logistic growth constant Logistic growth model Newton's Law of Cooling Numerical method Numerical solution of a differential equation Order of a Differential equation Partial fraction decomposition Particular solution Proper rational function

				Properties of Indefinite Integrals Radioactive Radioactive decay Resistance proportional to velocity Second-order of a differential equation Separable differential equation Separation of variables Slope Field Solution to a differential equation Substitution in definite integrals Tabular integration Variable of integration
Unit-8- Applications of Integration **~20 days**			8.1 Finding the Average Value of a Function on an Interval 1 CHA 8.2 Connecting Position, Velocity, and Acceleration of Functions Using Integrals 8.3 Using Accumulation Functions and Definite Integrals in Applied Contexts 8.4 Finding the Area Between Curves Expressed as Functions of x 8.5 Finding the Area Between Curves Expressed as Functions of y 8.6 Finding the Area Between Curves That Intersect at More Than Two Points	Unit 8 Accumulation Area between curves Cavalier's Theorem Center of mass Constant force formula Cylindrical shells Displacement Fluid force Fluid pressure

			8.7 Volumes with Cross Sections: Squares and Rectangles 8.8 Volumes with Cross Sections: Triangles and Semicircles 8.9 Volume with Disc Method: Revolving Around the x- or y-Axis 8.10 Volume with disc method: revolving around other axes 8.11 Volume with Washer Method: Revolving Around the x- or y-Axis 8.12 Volume with washer method: revolving around other axes	Foot- pound Force constant Gaussian curve Hooke's Law Inflation rate Joule Mean Moment Net change Newton Normal curve Normal PDF (Probability Density Function) Solid of revolution Standard deviation Surface area Total distance travelled Universal gravitational constant Volume by cylindrical shells Volume by slicing Volume of a solid Weight density work
Review for AP Exam ~24 days Test ~ on May 5th			Review Previous years Free-Response Questions	

Applications of Logistic, and Financial Functions ~15 days			Epidemics, Biome carrying capacity, investments loans, car loans, credit cards, Car insurance.	