HUDSONVILLE HIGH SCHOOL COURSE FRAMEWORK

COURSE / SUBJECT AP Calculus (AB)

KEY COURSE OBJECTIVES/ENDURING UNDERSTANDINGS	OVERARCHING/ESSENTIAL SKILLS OR QUESTIONS
Limits and Continuity	Make sense of problems and persevere in solving them.
Derivatives	Reason abstractly and quantitatively.
More Derivatives	Construct viable arguments and critique the reasoning of others.
Applications of Derivatives	Model with mathematics.
The Definite Integral	Use appropriate tools strategically.
Differential Equations and Mathematical Modeling	Attend to precision.
Applications of Definite Integrals	Look for and make use of structure.
	Look for and express regularity in repeated reasoning.

PACING	LESSON	STANDARD	LEARNING TARGETS	KEY CONCEPTS
Chapter 1 *Prerequisites for Calculus* (7 days)	1.1 *Lines*	College Board Prerequisites for *Calculus (AB)*	Use increments to calculate slopes. Write an equation and sketch a graph of a line given specific information. Use relationship between parallel/perpendicular lines and slopes. Use linear regression equations to solve problems.	Increments • Slope of a Line • Parallel and Perpendicular Lines • Equations of Lines • Applications
	1.2 *Functions and Graphs*		Identify domain & range of a function using graph/equation. Recognize even and odd functions using equation/graph. Interpret and find formulas for piecewise defined functions. Write and evaluate compositions of two functions.	Functions • Domains and Ranges • Viewing and Interpreting Graphs • Even and Odd Functions - Symmetry • Functions Defined in Pieces • Absolute Value Function • Composite Functions
	1.3 *Exponential Functions*		Determine the domain, range, and graph of an exponential function. Solve problems involving exponential growth and decay, or exponential regression equation.	Exponential Growth • Exponential Decay • Applications • The Number *e*
	1.4 *Parametric Functions*		Graph curves that are described using parametric equations. Convert parametric equations to Cartesian form.	Relations • Circles • Ellipses • Lines and Other Curves
	1.5 *Functions and Logarithms*		Identify a one-to-one function. Determine the algebraic and graphical representations of various functions and its inverse. Apply properties of logarithms. Solve problems using logarithmic regression.	One-to-One Functions • Inverses • Finding Inverses • Logarithmic Functions • Properties of Logarithms • Applications
	1.6 *Trigonometric Functions*		Convert between radians & degrees, and find arc length. Identify the period, even-odd properties, and find values of trigonometric functions. Understand various transformations of trig graphs. Use inverse trig functions to solve problems.	Radian Measure • Graphs of Trig Functions • Periodicity • Even and Odd Trig Functions • Transformations of Trig Graphs • Inverse Trig Functions

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Chapter 2 *Limits and Continuity* (11 days)	2.1 *Rates of Change and Limits*	College Board *Calculus (AB)* Standard I Limits of functions (including one-sided limits) Asymptotic and unbounded behavior Continuity as a property of functions	Calculate average and instantaneous speeds. Define and calculate limits for function value and apply the properties of limits. Use the Sandwich Theorem to find certain limits indirectly.	Average and Instantaneous Speed • Definition of Limit • Properties of Limits • One-sided and Two-sided Limits • Sandwich Theorem
	2.2 *Limits Involving Infinity*		Find and verify end behavior models for various function. Calculate limits as and to identify vertical and horizontal asymptotes.	Finite Limits as $x \to \pm\infty$ and their Properties • Sandwich Theorem Revisited • Limits as $x \to a$ • End Behavior Models • "Seeing" Limits as $x \to \pm\infty$
	2.3 *Continuity*		Identify the intervals upon which a given function is continuous and understand the meaning of continuous function with and without limits. Remove removable discontinuities by extending of modifying a function. Apply the Intermediate Value Theorem and the properties of algebraic combinations and composites of continuous functions.	Continuity as a Point • Continuous Functions • Algebraic Combinations • Composites • Intermediate Value Theorem for Continuous Functions
	2.4 *Rates of Change and Tangent Lines*		Apply directly the definition of the slope of a curve in order to calculate slopes. Find the equations of the tangent line and normal line to a curve at a given point. Find the average rate of change of a function.	Average Rates of Change • Tangent to a Curve • Slope of a Curve• Normal to a Curve • Speed Revisited

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Chapter 3 *Derivatives* (12 days)	3.1 *Derivative of a Function*	College Board *Calculus (AB)* Standards I and II Continuity as a property of functions Concept of the derivative Derivative at a point Derivative as a function Second derivatives Computation of derivatives Applications of derivatives	Calculate slopes and derivatives using the definition of derivative. Graph f from the graph of f' and graph f' from the graph of f.	Definition of Derivative • Notation • Relationships Between the Graphs of f and f' • Graphing the Derivative from Data • One-sided Derivatives
	3.2 *Differentiability*		Be able to find where a function is not differentiable and distinguish between corners, cusps, discontinuities, and vertical tangents. Be able to approximate derivatives numerically and graphically.	How $f'(a)$ Might Fail to Exist • Differentiability Implies Local Linearity • Numerical Derivatives on a Calculator • Differentiability Implies Continuity • Intermediate Value Theorem for Derivatives
	3.3 *Rules for Differentiation*		Use the rules of differentiation to calculate derivatives, including second and higher order derivatives. Use the derivative to calculate the instantaneous rate of change.	Derivative Rules for Positive Integer Powers, Multiples, Sums, Differences, Products and Quotients • Negative Integer Powers of x • Second and Higher Order Derivatives
	3.4 *Velocity and Other Rates of Change*		Use derivatives to analyze straight line motion and solve other problems involving rates of change.	Instantaneous Rates of Change • Motion Along a Line • Sensitivity to Change • Derivatives in Economics
	3.5 *Derivatives of Trigonometric Functions*		Use the rules for differentiating the six basic trigonometric functions.	Derivatives of the Sine Function and Cosine Function • Simple Harmonic Motion • Jerk • Derivatives of the Other Basic Trigonometric Functions

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Chapter 4 *More Derivatives* (15 days)	4.1 *Chain Rule*	College Board Calculus (AB) Standards I and II Continuity as a property of functions Concept of the derivative Derivative at a point Derivative as a function Second derivatives Computation of derivatives Applications of derivatives	Differentiate composite functions using the Chain Rule. Find the slopes of parametrized curves.	Derivative of a Composite Function • Use of the Chain Rule ("Outside-Inside") • Slopes of Parametrized Curves • Power Chain Rule
	4.2 *Implicit Differentiation*		Find derivatives using implicit differentiation, and the Power Rule for Rational Powers of x.	Implicitly Defined Functions • Tangents & Normal Lines • Derivatives of Higher Order • Rational Powers of Differentiable Functions
	4.3 *Derivatives of Inverse Trigonometric Functions*		Calculate derivatives of functions involving the inverse trigonometric functions.	Derivatives of Inverse Functions • Derivative of Arcsine, Arctangent and Arcsecant • Derivatives of the Other Three
	4.4 *Derivatives of Exponential and Logarithmic Functions*		Calculate derivatives of exponential and logarithmic functions.	Derivative of e^x , a^x, $\ln x$, $\log_a x$ • Power Rule for Arbitrary Real Powers

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Chapter 5 *Applications of Derivatives* (19 days)	5.1 *Extreme Values of Functions*	College Board Calculus (AB) Standard II Applications of derivatives	Determine the local or global extreme values of a function.	Absolute (Global) Extreme Values • Local (Relative) Extreme Values • Finding Extreme Values (Critical Point)
	5.2 *Mean Value Theorem*		Apply the Mean Value Theorem and find the intervals on which a function is increasing or decreasing.	Mean Value Theorem • Physical Interpretation • Increasing and Decreasing Functions • Other Consequences and Antiderivatives
	5.3 *Connecting f' and f" with the Graph of f*		Use the First and Second Derivative Tests to determine the local extreme values of a function. Determine the concavity of a function and locate the points of inflection by analyzing the second derivative. Graph *f* using information about *f'* and/or *f"*.	First Derivative Test for Local Extrema • Concavity • Points of Inflection • Second Derivative Test for Local Extrema • Learning about Functions from Derivatives
	5.4 *Modeling and Optimization*		Solve application problems involving finding minimum or maximum values of functions.	Examples from Mathematics, Business, Industry, and Economics • Modeling Discrete Phenomena with Differentiable Functions
	5.5 *Linearization and Differentials*		Find linearizations and differentials, and estimate the change in a function using differentials.	Linear Approximation • Differentials and Estimating Change with Differentials • Absolute, Relative, and Percent Change • Newton's Method
	5.6 *Related Rates*		Solve related rates problems.	Related Rates Equations • Solution Strategy

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Chapter 6 *The Definite Integral* (18 days)	6.1 *Estimating with Finite Sums*	College Board Calculus (AB) Standard III Interpretations and properties of definite integrals Applications of integrals Fundamental Theorem of Calculus Techniques of antidifferentiation Numerical approximations to definite integrals	Approximate the area under the graph of a nonnegative continuous function by using rectangle approximation methods. Interpret the area under a graph as a net accumulation of a rate of change.	Distance Traveled • Rectangular Approximation Method (RAM)
	6.2 *Definite Integrals*		Express the area under a curve as a definite integral and as a limit of Riemann sums. Compute the area under a curve using varied numerical integration procedures.	Riemann Sums • Terminology and Notation of Integration • Definite Integral and Area • Constant Functions • Integrals on a Calculator • Discontinuous Integrable Functions
	6.3 *Definite Integrals and Antiderivatives*		Apply rules for definite integrals and find the average value of a function over a closed interval.	Properties of Definite Integrals • Average Value of a Function • Mean Value Theorem for Definite Integrals • Connecting Differential and Integral Calculus
	6.4 *Fundamental Theorem of Calculus*		Apply the Fundamental Theorem of Calculus. Understand the relationship between the derivative and definite integral a expressed in both parts of the Fundamental Theorem of Calculus.	Fundamental Theorem of Calculus (Part 1) • Graphing the Function $\int_a^x f(t)dt$ • Fundamental Theorem of Calculus (Part 2) • Area Connection • Analyzing Antiderivatives Graphically
	6.5 *Trapezoidal Rule*		Approximate the definite integral by using the Trapezoidal Rule and by using Simpson's Rule.	Trapezoidal Approximations • Simpson's Rule

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Chapter 7 (except 7.3) *Differential Equations and Mathematical Modeling* (16 days)	7.1 *Slope Field and Euler's Method*	College Board Calculus (AB) Standards II and III Applications of derivatives Techniques of antidifferentiation Applications of antidifferentiation	Construct antiderivatives using the Fundamental Theorem of Calculus. Solve initial value problems in the form $\frac{dy}{dx} = f(x)$, $y_0 = f(x_0)$. Construct slope fields and interpret slope fields as visualizations of different equations. Use Euler's Method for graphing a solution to an initial value problem.	Differential Equations • Initial Value Problems • Slope Fields • Euler's Method
	7.2 *Antidifferentiation by Substitution*		Compute indefinite and definite integrals by the method of substitution.	Indefinite Integrals • Leibniz Notation and Antiderivatives • Substitution in Indefinite Integrals • Substitution in Definite Integrals
	7.4 *Exponential Growth and Decay*		Solve problems involving exponential growth and decay in a variety of situations and applications.	Separable Differential Equations • Law of Exponential Change • Continuously Compounded Interest • Radioactivity • Modeling Growth with Other Bases • Newton's Law of Cooling
	7.5 *Logistic Growth*		Solve varied problems involving logistic growth without using the partial fractions technique.	How Populations Grow • The Logistic Differential Equation • Logistic Growth Models

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Chapter 8 *Applications of Definite Integrals* (15 days)	8.1 *Integral as Net Change*	College Board Calculus (AB) Standard III Applications of integrals	Solve problems in which a rate is integrated to find the net change over time in a variety of applications.	Integral as Net Change • Strategy for Modeling with Integrals • Consumption Over Time • Net Change from Data
	8.2 *Areas in the Plane*		Use integration to calculate areas of regions in a plane.	Area Between Curves • Area Enclosed by Intersecting Curves • Boundaries with Changing Functions • Integrating with Respect to y • Saving Time with Geometry Formulas
	8.3 *Volumes*		Use integration by slices to calculate volumes of solids and the volumes of solids of revolution.	Volume as an Integral • Cross Sections without Rotation • Circular Cross Sections (disk and washer)
	8.4 *Lengths of Curves*		Use integration to calculate lengths of curves in a plane. Use integration to calculate surface areas of solids of revolution.	Length of a Smooth Curve • Vertical Tangents, Corners, and Cusps
Chapter 9	9.2 *L'Hôpital's Rule*		Find limits of indeterminate forms using L'Hôpital's Rule.	L'Hôpital's Rule • Indeterminate Form 0/0 • L'Hôpital's Rule and One Sided-Limits • Indeterminate Forms ∞/∞, $\infty \cdot 0$, $\infty - \infty$