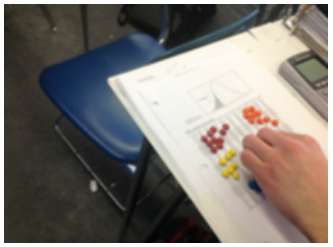
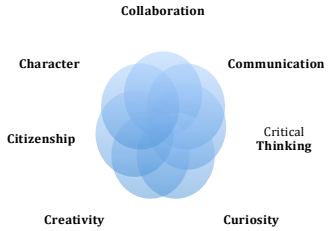
Content Area: Mathematics	Course: Calculus Honors	Grade Level: 12
	**R14 The Seven Cs of Learning** 	

Unit Titles	Length of Unit
• Prerequisite Review	1 week
• Limits and Continuity	3-4 weeks
• Introduction to Derivatives	3-4 weeks
• Marginal Analysis, Estimation and Chain Rule	2-3 weeks
• Implicit Differentiation	2 weeks
• Related Rates and Higher Order Derivatives	2-3 weeks
• Sketch Graphs Using Derivatives	2-3 weeks
• Optimization	2 weeks
• Exponential and Logarithmic Functions	1-2 weeks
• Derivatives of Exponential and Logarithmic functions	3-4 weeks
• Introduction to Integration	2-3 weeks
• Integration by Substitution	2-3 weeks

Strands	Course Level Expectations
Number and Quantity	• Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.* • Rewrite expressions involving radicals and rational exponents using the properties of exponents. • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. • Define appropriate quantities for the purpose of descriptive modeling.
Algebra	• Interpret expressions that represent a quantity in terms of its context.* • Use the structure of an expression to identify ways to rewrite it. *For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.* • Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.* • Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. • (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions. • Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.* • Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*

	• Solve quadratic equations in one variable. • Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$. • Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
Functions	• For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity*.* • Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* • Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* • Write a function that describes a relationship between two quantities.* • Find inverse functions. • (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. • Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function • Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. • Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. • Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.* • (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.* • Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.

Unit Title	Prerequisite Review	Length of Unit	1 week

Inquiry Questions (Engaging & Debatable)	● How do concepts from Calculus lay the framework for studying end behavior of functions, instantaneous rate of change, and area under the curve? ● What similarities exist in the way we study different families of functions?
Standards	**Seeing Structure in Expressions:** HSA.SSE.A.1, HSA.SSE.A.2, HSA.SSE.B.3, **Arithmetic with Polynomials & Rational Expressions** HSA.APR.B.3, HSA.APR.D.7, **Creating Expressions:** HSA.CED.A.2, HSA.CED.A.3, HSA.CED.A.4 **Reasoning with Equations & Inequalities** HSA.REI.B.4, HSA.REI.C.7, HSA.REI.D.10 **Interpreting Functions:** HSF.IF.B.4, HSF.IF.B.6, HSF.IF.C.7, **Building Functions:** HSF.BF.A.1 **Trigonometric Functions** HSF.TF.A.1, HSF.TF.A.2, HSF.TF.A.5, HSF.TF.A.7, HSF.TF.A.8, HSF.IF.C.7,
Unit Strands & Concepts	● Functions, domain and range, continuity, graphing, composition of functions, write equations, application problems
Key Vocabulary	Function, domain, range, slope, continuous function, discontinuous function, representations, composition

Unit Title	Prerequisite Review	Length of Unit	1 week

Critical Content: My students will **Know**…	Key Skills: My students will be able to **(Do)**…
• What a function is in various representations; graphs, equations, tables • What the domain and range of a function is • How to graph different types of functions; linear, polynomial, rational, piecewise • How to write equations given information • What composition of functions means	• Determine if relations are functions from different representations • State the domain and range of functions in different representations • Graph different types of functions; linear, polynomial, rational, piecewise • Write equations given information • Perform composition of functions

Assessments:	• Prerequisite Review packet • Prerequisite Test
Teacher Resources:	Calculus Honors Implementation Guide

Unit Title	Limits and Continuity	Length of Unit	3-4 weeks

Inquiry Questions (Engaging & Debatable)	• How can limits help understand the behavior of functions? • How can limits be used to define continuity of a function?
Standards	**Seeing Structure in Expressions:** HSA.SSE.B.3 **Interpreting Functions:** HSF.IF.C.7
Unit Strands & Concepts	• Find limits numerically • Find limits graphically • Find limits algebraically • Determine continuity at a point
Key Vocabulary	Limit, continuity, removable discontinuity, Infinite discontinuity, Jump discontinuity, analyze, symbolic, end behavior, notation,

Unit Title	Limits and Continuity	**Length of Unit**	3-4 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• The definition of a limit • Proper notation of a limit • Concept of limit can be extended to include one-sided limits • A limit may not exist for some functions at a particular x value • End behavior of a graph can be described using limits • Definition of continuity • Different types of discontinuity	• Express limits symbolically with proper notation • Interpret limits • Estimate limits numerically and graphically • Evaluate limits algebraically • Interpret behavior of functions using limits • Analyze functions for points of discontinuity

Assessments:	• Basic limits and continuity quiz • Unit Test
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Introduction to Derivatives	Length of Unit	3-4 weeks

Inquiry Questions (Engaging & Debatable)	• What is a derivative? • What happens to the slope between two points as they come infinitely close to one another?
Standards	HSN.RN.A.1, HSN.RN.A.2 **Seeing Structure in Expressions:** HSA.SSE.A.2, HSA.SSE.B.3 **Interpreting Functions:** HSF.IF.B.6
Unit Strands & Concepts	• Difference Quotient • Take limit of difference quotient • Slope of tangent line • Differentiation rules; power rule, sum and difference rule, product rule, quotient rule • Derivative applications - rate of change
Key Vocabulary	Derivative, instantaneous rate of change, velocity, interval, quotient, notation, tangent, slope

Unit Title	Introduction to Derivatives	Length of Unit	3-4 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
● The difference quotient expresses the rate of change over an interval ● The derivative is instantaneous rate of change at one point ● The derivative is the equation to find the slope of the tangent line ● Proper derivative notation ● The first derivative is velocity of a distance function	● Evaluate the derivative by taking the limit of the difference quotient ● Calculate the derivative using differentiation rules ● Write the equation of the tangent line to a specific point on a curve ● Solve rate of change application problems using the derivative ● Determine velocity of a moving object

Assessments:	● Difference quotient and derivative formative assessments ● Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Marginal Analysis, Estimation and Chain Rule	Length of Unit	2-3 weeks

Inquiry Questions (Engaging & Debatable)	• Why is the derivative a useful tool? • How is the derivative of a composition of functions related to the behavior of the original functions?
Standards	**The Real Number System:** HSN.RN.A.1, HSN.RN.A.2, **Quantities:** HSN.Q.A.1, HSN.Q.A.2 **Seeing Structure in Expressions:** HSA.SSE.A.2, HSA.SSE.B.3, **Interpreting Functions:** HSF.IF.B.6, HSF.BF.A.1,
Unit Strands & Concepts	• Marginal analysis - use derivative • Estimate rate of change (percentage rate) for a small change in independent variable • Chain rule for differentiation of composite functions
Key Vocabulary	Marginal cost , Marginal revenue, Marginal profit, composite, chain rule, variable, application, estimation,

Unit Title	Marginal Analysis, Estimation and Chain Rule	Length of Unit	3-4 weeks

Critical Content: My students will **Know**…	Key Skills: My students will be able to **(Do)**…
• Marginal analysis is a business method of determining the impact of producing x number of goods • Estimation formulas • The chain rule should be used to find the derivative of a composite function	• Use derivatives to solve marginal analysis application problems • Estimate rate of change for a small change in the independent variable • Estimate percentage rate of change for a small change in the independent variable • Use the chain rule to find the derivative of a composite function

Assessments:	• Marginal analysis and estimation Assessment • Chain rule Assessment • Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Implicit Differentiation	**Length of Unit**	2 weeks

Inquiry Questions (Engaging & Debatable)	• Why do we need implicit differentiation? • How can we differentiate a function in terms of several variables?
Unit Strands & Standards	**Seeing Structure in Expressions:** HSA.SSE.A.2, HSA.SSE.B.3 **Interpreting Functions:** HSF.IF.B.6
Concepts	• Implicit differentiation • Implicit vs explicit differentiation • Chain rules
Vocabulary	Implicit differentiation, explicit differentiation, derivative, chain rule, implicit equation, derivative implicity

Unit Title	Implicit Differentiation	**Length of Unit**	2 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• Chain rule is the basis of implicit differentiation • How implicit and explicit differentiation differ	• Find the derivative of an implicit equation • Show that taking the derivative implicitly and explicitly yields the same answer

Assessments:	• Implicit differentiation assessment • Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Related Rates and Higher Order Derivatives	Length of Unit	2-3 weeks

Inquiry Questions (Engaging & Debatable)	• How can derivatives help determine the rate at which one variable is changing when multiple variables are involved? • How can we model the relationship between real life quantities and their rates of change?
Standards	**Quantities:** HSN.Q.A.1, HSN.Q.A.2, **Seeing Structure in Expressions:** HSA.SSE.A.1, **Creating Expressions:** HSA.CED.A.2, HSA.CED.A.3, HSA.CED.A.4, **Interpreting Functions:** HSF.IF.B.6 **Building Functions:** HSF.BF.A.1
Unit Strands & Concepts	• Functions over time • Related rates • Higher order derivatives • Solving applications
Key Vocabulary	Related rates, higher order derivatives, second derivative, acceleration, function, affect, notation, yield,

Unit Title	Related Rates and Higher Order Derivatives	Length of Unit	2-3 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• In a function, multiple variables can be affected by a change in time • Proper notation for higher order derivatives • Taking derivatives of derivatives will yield higher order derivatives	• Use derivatives to solve related rates problems • Find higher order derivatives • Solve applications using the second derivative

Assessments:	Tootsie Pop (Related Rates) Assessment Related rates formative assessment Higher order derivatives formative assessment Unit test
Teacher Resources:	● Calculus: For Business, Economics, and the Social Life Sciences ● Calculus: Graphical, Numerical, Algebraic

Unit Title	Sketch Graph Using Derivatives	Length of Unit	2-3 weeks

Inquiry Questions (Engaging & Debatable)	• How can the derivative of a function be used to understand the behavior of the original function? • What aspects of a function are most important for understanding the shape of the graph of a function?
Standards	**Interpreting Functions:** HSF.IF.B.4, HSF.IF.B.6, HSF.IF.C.7,
Unit Strands & Concepts	• Graph continuous functions using first derivative test • Graph discontinuous functions using the first derivative test • Graph function using first and second derivative tests • Sketch graph to meet given properties
Key Vocabulary	Extrema, non-extrema, concavity, points of inflection, inflection, accuracy, derivative, properties

Unit Title	Sketch Graphs Using Derivatives	Length of Unit	2-3 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
● First derivative provides specific information about the function and its graph - intervals of increase/decrease and extrema ● Second derivative provides specific information about the function and its graph - concavity and points of inflection	● Use the first derivative to analyze and sketch the graph of the original function ● Use the second derivative to analyze and sketch a more accurate graph of the original function

Assessments:	• Formative Assessment sketching graphs using first derivative test • Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Solve Optimization Problems	Length of Unit	2 weeks

Inquiry Questions (Engaging & Debatable)	● Why is it necessary to find optimal solutions? ● What types of real world problems are solved using optimization?
Standards	**Seeing Structure in Expressions:** HSA.SSE.A.1, **Creating Expressions:** HSA.CED.A.2, HSA.CED.A.3, HSA.CED.A.4, **Interpreting Functions:** HSF.IF.B.6, **Building Functions:** HSF.BF.A.1,
Unit Strands & Concepts	• Analyze different real-world situations • Solve for optimal outcome using derivatives • Answer with proper units
Key Vocabulary	Optimization, optimal outcome, maximize, minimize, proper, derivatives

Unit Title	Solve Optimization Problems	Length of Unit	2 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• Derivatives can be used to find maximum or minimum values • The solution to an optimization problem involves finding maximum or minimum values	• Analyze real-world application problems • Solve optimization problems using derivatives • Give reasonable answer with proper units

Assessments:	• Optimization formative assessment • Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Exponential Functions	Length of Unit	1-2 weeks

Inquiry Questions (Engaging & Debatable)	● What real world phenomenon are modeled using exponential functions? ● How is an exponential function similar/different from a logarithmic function?
Standards	**Seeing Structure in Expressions:** HSA.SSE.B.3, **Creating Expressions:** HSA.CED.A.2 **Building Functions:** HSF.BF.A.1, HSF.BF.B.4, HSF.BF.B.5, **Linear, Quadratic, & Exponential Models:** HSF.LE.A.3,
Unit Strands & Concepts	• Parent functions • Use limits and parent functions to sketch graphs • Use exponential growth model to solve application problems
Key Vocabulary	Exponential growth model, Logistic/Sigmoidal curve, graph, parent function, sketch, exponent rules, limits

Unit Title	Exponential Functions	**Length of Unit**	1-2 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
● How the parent function and limits can be used to sketch graphs ● Exponent rules ● How graph of logistic curve differs from exponential curve ● How to use the exponential growth model to model exponential situations	● Take limits of exponential functions to sketch its graph ● Simplify expressions using exponent rules ● Sketch graph of logistic curve using limits ● Model real-world application problems using the exponential growth model

Assessments:	Exponentials quiz Unit test
Teacher Resources:	● Calculus: For Business, Economics, and the Social Life Sciences ● Calculus: Graphical, Numerical, Algebraic

Unit Title	Derivatives of Exponential and Logarithmic Functions	Length of Unit	3-4 weeks

Inquiry Questions (Engaging & Debatable)	● How is the derivative of an exponential function similar/different from the derivative of a logarithmic function? ● How can we find the derivative of any function using its inverse?
Standards	**Seeing Structure in Expressions:** HSA.SSE.B.3, **Interpreting Functions:** HSF.IF.B.6, **Building Functions:** HSF.BF.A.1, HSF.BF.B.4, HSF.BF.B.5, **Linear, Quadratic, & Exponential Models:** HSF.LE.A.3,
Unit Strands & Concepts	• Properties of logs • Natural log function and applications • Derivatives of natural log and exponential functions • Half-life and carbon dating applications • Logarithmic differentiation • Implicit differentiation of natural log and exponential functions
Key Vocabulary	Logarithmic differentiation, half-life, simplify, exponential, log equation, method, implicitly,

Unit Title	Derivatives of Exponential and logarithmic functions	Length of Unit	3-4 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
● Methods to solve natural log equations ● How to differentiate natural log and exponential equations ● How to model and solve half-life and carbon dating application problems ● When to take derivatives implicitly for log and exponential functions ● The process of logarithmic differentiation and when to use it	● Solve natural log equations ● Differentiate natural log and exponential equations- using prior methods as needed ● Model and solve half-life and carbon dating application problems ● Take derivatives implicitly for natural log and exponential functions ● Use logarithmic differentiation to simplify the derivative process

Assessments:	• Exponential and log formative assessment • Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Introduction to Integration	Length of Unit	2-3 weeks

Inquiry Questions (Engaging & Debatable)	• Why is it necessary to have an inverse process to differentiation? • What does the integral represent in a real world situation?
Standards	**Seeing Structure in Expressions:** HSA.SSE.A.2, HSA.SSE.B.3,
Unit Strands & Concepts	• Integration and notation • Indefinite integrals • Integration of products and quotients • Solve differential equations • Particular solution for an integral • Applications involving integration
Key Vocabulary	Antiderivative, integration, indefinite integral, differential equation, expressions, notation, functions, products

Unit Title	Introduction to Integration	Length of Unit	2-3 weeks

Critical Content: My students will **Know**…	Key Skills: My students will be able to **(Do)**…
● Proper notation of integration ● How to integrate expressions ● The antiderivative of a function f is a function g whose derivative is f (inverse) ● Indefinite integral is an infinite family of functions ● Recognize differential equations ● Methods to solve differential equations	● Integrate expressions including products and quotients ● Use proper notation for integrals and antiderivatives ● Find general (indefinite) antiderivatives ● Find particular antiderivatives, one specific member of the family ● Solve differential equations ● Solve application problems using integration

Assessments:	• Formative Assessments on indefinite integrals and particular integrals and solve differential equations • Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic

Unit Title	Integration by Substitution	Length of Unit	2-3 weeks

Inquiry Questions (Engaging & Debatable)	● How do we integrate composite functions? ● What do we look for to know that integration by substitution is possible?
Standards	**Seeing Structure in Expressions:** HSA.SSE.A.2, HSA.SSE.B.3,
Unit Strands & Concepts	• Integrate more complicated functions using integration by substitution • Rewriting a complicated integral • Integrate a complicated expressions
Vocabulary	Substitution, simplify, integrals, variable, expression, differential equations, customize

Unit Title	Integration by Substitution	Length of Unit	2-3 weeks

Critical Content: My students will **Know**…	Key Skills: My students will be able to **(Do)**…
● Integration by substitution is a method for more complicated integrals ● Assign variable (u) to part of integral to simplify ● Recognize when need to "customize" du to rewrite the complicated equation ● Recognize when to use substitution to solve differential equations	● Determine when it is necessary to use integration by substitution ● Rewrite a complicated integral by assigning a variable to represent part of the integral ● Integrate the complicated expression ● Solve complicated differential equations ● Solve real-world application problems

Assessments:	• Formative Assessment on integration by substitution • Summative Assessment
Teacher Resources:	Calculus: For Business, Economics, and the Social Life Sciences Calculus: Graphical, Numerical, Algebraic