WDHS Curriculum Map: Created by Lindsay Freedman and Andrea Kappre
Course: AP and Honors Calculus June 2016

Time Interval/ Content	*Standards/ Strands*	*Essential Questions*	*Skills*	*Assessment*
Unit 1: Limits and Continuity Honors: *Sullivan*: 1.1 - 1.5 AP: *Finney* 2.1 - 2.3	A-APR.6 Rewrite simple rational expressions in different forms. Write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), r(x) are polynomials with the degree r(x) less than the degree of b(x), using inspection, long division or for the more complicated examples, a computer algebra system. F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. TECH 8.1.12.A.3	How can the concept of a limit be used to understand the behavior of functions? How is continuity defined using limits?	*Students will know……* ● Given a function, *f*, the limit of *f*(*x*) as *x* approaches *c* is a real number *R* if *f*(*x*) can be made arbitrarily close to *R* by taking *x* close to, but not equal to *c*. If the limit exists and is a real number then the common notation is $\lim_{x \to c} f(x) = R$. ● The concept of a limit can be extended to include one-sided limits, limits at infinity, and infinite limits. ● A limit might not exist for some functions at particular values of *x*. Some ways that the limit might not exist are if the function is unbounded, if the function is oscillating near this value, or if the limit from the left does not equal the limit from the right. ● Numerical and graphical information can be used to estimate limits. ● Limits of sums, differences, products, quotients, and composite functions can be found using the basic theorems of limits and algebraic rules.	● Quizzes ● Unit Test ● Performance Task ● Midterm Exam ● Final Exam

	Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or an issue. TECH 8.2.12.E.1 Demonstrate an understanding of the problem solving capacity of computers in our world.		● The limit of a function may be found by using algebraic manipulation, alternative forms of trigonometric functions, or the squeeze theorem. ● Asymptotic and unbounded behavior of functions can be explained and described using limits. ● Relative magnitudes of functions that their rates of change can be compared using limits. ● A function f is continuous at $x = c$ provided that $f(x)$ exists, the limit as x approaches c exists, and the limit as x approaches $c = f(c)$. ● Polynomial, rational, power, exponential, logarithmic, and trigonometric functions are continuous at all points in their domains. ● Types of discontinuities include removable discontinuities, jump discontinuities, and discontinuities due to vertical asymptotes. ● Continuity is an essential condition for theorems such as the Intermediate Value Theorem, the Extreme Value Theorem, and the Mean Value Theorem. *Students will be able to…..*	

			• Express limits symbolically using correct notation • Interpret limits expressed symbolically • Estimate limits of functions • Determine the limits of functions. • Deduce and interpret behavior of functions using limits. • Analyze functions for intervals of continuity or points of discontinuity. • Determine the ability of important calculus theorems using continuity.	
Unit 2: The Derivative Honors: *Sullivan* 2.1 - 2.5 and 3.1 - 3.3 AP: *Finney* 2.4 and 3.1 - 3.9	N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. A.SSE.1 Interpret expressions that represent a quantity in terms of its context F-IF.6 Calculate and interpret the average rate of change of a function over a specified interval. Estimate the rate of change from a graph F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.	How can the derivative of a function be defined as the limit of a difference quotient? What are the multiple interpretations of the derivative? Which rules can be used to determine the derivative of a function?	*Students will know……* • The difference quotients $\frac{f(a+h)-f(a)}{h}$ and $\frac{f(x)-f(a)}{x-a}$ express the average rate of change of a function over an interval. • The tangent line is the graph of a locally linear approximation of the function near the point of tangency. • The instantaneous rate of change can be expressed by $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$ or $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$, provided that the limit exists. These are common forms of the definition	• Quizzes • 2 Unit Tests • Performance Task • Midterm Exam • Final Exam

	F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4, and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π-*x*, π+*x*, and 2π-*x* in terms of their values for *x*, where *x* is any real number. F-TF.7 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. TECH 8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or an issue. TECH 8.2.12.E.1 Demonstrate an understanding of the problem solving capacity of computers in our world.		of the derivative and are denoted *f* '(*a*). ● The derivative of *f* is the function whose value as *x* is $\lim_{h \to 0} \frac{f(a+h) - f(a)}{h}$ provided this limit exists. ● The derivative of a function can be interpreted as the instantaneous rate of change with respect to its independent variable. ● The derivative can be used to express information about rates of change in applied contexts. ● The derivative at a point is the slope of the line tangent to a graph at that point on the graph. ● For *y* = *f*(*x*), notations for the derivative include *dy*/*dx*, *f* '(*x*), and *y'*. ● The derivative can be expressed graphically, numerically, analytically, and verbally. ● The derivative at a point can be estimated from information given in tables or graphs. ● Direct application of the definition of the derivative can be used to find the derivative for selected functions, including polynomial, power, sine, cosine, exponential, and logarithmic functions.	

			• A continuous functions may fail to be differentiable at a point in its domain. • If a function is differentiable at a point, then it is continuous at that point. • Specific rules can be used to calculate derivatives for classes of functions, including polynomial, rational, power, exponential, logarithmic, trigonometric, and inverse trigonometric. • Sums, differences, products, and quotients of functions can be differentiated using derivative rules. • Differentiating *f ’* produces the second derivative *f* “, provided the derivative of *f* ‘ exists; repeating this process produces higher order derivatives of *f*. • Higher order derivatives are represented with a variety of notations. For *y* = *f*(*x*), notations for the second derivative include d^2y/dx^2, *f* “(*x*), and *y*”. Higher order derivatives can be denoted d^ny/dx^n or $f^n(x)$. • The derivative can be used to solve rectilinear motion problems involving position, speed, velocity, and acceleration.	

			- The chain rule provides a way to differentiate composite functions. - The chain rule is the basis for implicit differentiation. - The chain rule can be used to find the derivative of an inverse function, provided the derivative of that function exists. *Students will be able to…..* - Identify the derivative of a function as the limit of a difference quotient. - Interpret the meaning of a derivative within a problem. - Estimate derivatives. - Solve problems involving rates of change in applied contexts. - Solve problems involving the slope of a tangent line. - Recognize the connection between differentiability and continuity. - Calculate derivatives. - Determine the higher order derivatives. - Solve problems involving rectilinear motion.	
Unit 3: Application of Derivatives Honors: *Sullivan* 4.1 - 4.7	N-Q.1 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	How can a function's derivative be used to understand the behavior of the function? How does the Mean Value Theorem connect the	*Students will know……* First and second derivatives of a function can provide information about the function and its graph including intervals of increase or decrease, local (relative) and global (absolute)	- Quizzes 2 Unit Tests - Performance Task - Midterm Exam - Final Exam

AP: *Finney* 4.1 - 4.4, 4.6, and 8.2 - 8.3	N-Q.2 Define appropriate quantities for the purpose of descriptive modeling N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A-APR.2 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. A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scale. A-CED.3 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. A-CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. A-REI.4 Solve quadratic equations in one variable.	behavior of a differentiable function over an interval to the behavior of the derivative of that function at a particular point in the interval? What are the multiple applications of the derivative?	extrema, intervals of upward or downward concavity, and point of inflection. ● Key features of functions and their derivatives can be identified and related to their graphical, numerical, and analytic representations. ● Key features of the graphs of *f*, *f* ‘, and *f* “ are related to one another. ● If a function *f* is continuous over the interval [*a*, *b*] and differentiable over the interval (*a*, *b*), the Mean Value Theorem guarantees a point within that open interval where instantaneous rate of change equals the average rate of change over the interval. ● The derivative can be used to solve related rates problems that is, finding a rate at which one quantity is changing by relating it to other quantities whose rate of change are known. ● The derivative can be used to solve optimization problems, that is, finding the maximum or minimum value of a function over a given interval. ● Limits of the determinate form 0/0 and infinity/infinity may be evaluated using L’Hospital’s Rule.	

	F-IF.4 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. F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4, and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π-*x*, π+*x*, and 2π-*x* in terms of their values for *x*, where *x* is any real number. F-TF.7 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.		*Students will be able to…..* ● Use derivatives to analyze properties of a function. ● Apply the Mean Value Theorem to describe the behavior of a function over an interval. ● Solve problems involving related rates and optimization ● Apply definite integrals to problems involving average value of a function. ● Apply definite integrals to problems involving motion.	

	G-GMD.3 Use volume formulas for cylinders, pyramids, cones and spheres to solve problems. TECH 8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or an issue. TECH 8.2.12.E.1 Demonstrate an understanding of the problem solving capacity of computers in our world.			
Unit 4: The Integral Honors: *Sullivan* 5.1 - 5.4 AP: *Finney* 5.1 - 5.5 and 6.2	N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. A.SSE.1 Interpret expressions that represent a quantity in terms of its context F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. F-TF.3 Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4, and π/6, and use the	What is antidifferentiation? How can the definite integral of a function over an interval be calculated using Riemann sums? Which rules can be used to determine the definite integral? How does the Fundamental Theorem of calculus connect integration to differentiation?	*Students will know……* ● An antiderivative of a function *f* is a function *g* whose derivative is *f*. ● Differentiation rules provide the foundation for finding antiderivatives. ● A Riemann sum is the sum of products, each of which is the value of the function as a point in a subinterval multiplied by the length of that subinterval of the partition. ● The definite integral of a continuous function *f* over the interval [*a*, *b*], denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0.	● Quizzes ● Unit Test ● Performance Task ● Final Exam

	unit circle to express the values of sine, cosine, and tangent for π-*x*, π+*x*, and 2π-*x* in terms of their values for *x*, where *x* is any real number. TECH 8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or an issue. TECH 8.2.12.E.1 Demonstrate an understanding of the problem solving capacity of computers in our world.		That is $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$ where x_i^* is a value in the *i*th subinterval, Δx_i is the width of the *i*th subinterval, *n* is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n \to \infty} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$ where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is the value of the *i*th subinterval. ● The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral. ● Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally. ● Definite integrals can be approximated using a left Riemann Sum, a midpoint Riemann Sum, or a trapezoidal sum. Approximations can be computed using either uniform or nonuniform partitions. ● A definite integral can be evaluated by using geometry	

			and the connection between the definite integral and area. ● Properties of definite integrals include the integral of constant times a function, the integral of the sum of two functions, reversal of limits of integration and the integral of a function over adjacent intervals. ● The definition of the definite integral may be extended to functions with removable or jump discontinuities. ● The definite integral can be used to define new functions. ● If *f* is a continuous on the interval [*a*, *b*], then $\frac{d}{dx}\left(\int_a^x f(t)dt\right) = f(x)$, where *x* is between *a* and *b*. ● Graphical, numerical, analytical, and verbal representations of a function *f* provide information about the function *g* defined as $g(x) = \int_a^x f(t)dt$. ● The function defined by $F(x) = \int_a^x f(t)dt$ is an antiderivative of *f*. ● If *f* is continuous on the interval [*a*,*b*] and *F* is an antiderivative of *f*, then $\int_a^b f(x)dx = F(b) - F(a)$. ● The notation $\int f(x)dx = F(x) + C$ means	

			that $F'(x) = f(x)$ and $\int f(x)dx$ is called the indefinite integral of the function *f*. ● Many functions do not have closed form antiderivatives. ● Techniques for finding antiderivatives include algebraic manipulation. ● A function defined as an integral represents an accumulation of a rate of change. ● The definite integral of the rate of change of a quantity over an interval gives the net change of that quantity over that interval. ● The limit of an approximating Riemann sum can be interpreted as a definite integral. ● The average value of a function *f* over an interval [*a*,*b*] is $\frac{1}{b-a}\int_a^b f(x)dx$. ● For a particle in rectilinear motion over an interval of time, the definite integral of velocity represents the particle's displacement over the interval of time, and the total distance traveled over the interval of time. *Students will be able to…..* ● Recognize antiderivatives of basic functions.	

			- Interpret the definite integral as the limit of a Riemann sum. - Express the limit of a Riemann sum in integral notation. - Approximate a definite integral. - Calculate a definite integral using areas and properties of definite integrals. - Analyze functions defined by an integral. - Calculate antiderivatives - Evaluate definite integrals. - Interpret the meaning of a definite integral within a problem.	
Unit 5: Applications of the Integral Honors: *Sullivan* 6.1 - 6.4 AP: *Finney* 7.1 - 7.3	N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. N-Q.2 Define appropriate quantities for the purpose of descriptive modeling N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. F-BF.1 Write a function that describes a relationship between two quantities. N-Q.1	How can the definite integral of a function over an interval be used to find the area of a region? How can the definite integral of a function over an interval be used to find the volume of a solid?	*Students will know……* - Areas of certain regions in the plane can be calculated with definite integrals. - Volumes of solids with known cross sections, including disc and washers, can be calculated with definite integrals. - The definite integral can be used to express information about accumulation and net change in many applied contexts. *Students will be able to…..* - Apply definite integrals to problems involving area and volume.	- Quizzes - Unit Test - Performance Task - Final Exam

	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 G-GMD.4 Identify the shape of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. TECH 8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or an issue. TECH 8.2.12.E.1 Demonstrate an understanding of the problem solving capacity of computers in our world.		● Use the definite integral to solve problems in various contexts.	
Unit 6: Differential Equations AP: *Finney*	8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.	How is antidifferentiation an underlying concept involved in solving differential equations?	*Students will know……* ● Solutions to differential equations are functions or families of functions. ● Derivatives can be used to verify that a functions is a	● Quizzes ● Unit Test ● Performance Task ● Final Exam

6.1 and 6.4	N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. A.SSE.1 Interpret expressions that represent a quantity in terms of its context F-IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. TECH 8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or an issue. TECH 8.2.12.E.1	What is being determined when solving a separable differential equation?	solution to a given differential equation. ● Slope fields provide visual clues to the behavior of solutions to first order differential equations. ● Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay. ● Some differential equations can be solved by separation of variables. ● Solutions to differential equations may be subject to domain restrictions. ● The function *F* defined by $F(x) = c + \int_a^x f(t)dt$ is a general solution to the differential equation *dy*/*dx* = *f*(*x*), and $F(x) = y_0 + \int_a^x f(t)dt$ is a particular solution to the differential equations *dy*/*dx* = *f*(*x*) satisfying $F(a) = y_0$. ● The model for exponential growth and decay that arises from the statement "The rate of change of a quantity is proportional to size of the quantity" is *dy*/*dt* = *ky*.	

	Demonstrate an understanding of the problem solving capacity of computers in our world.		*Students will be able to.....* ● Verify solutions to differential equations. ● Estimate solutions to differential equations. ● Analyze differential equations to obtain general and specific solutions. ● Interpret, create, and solve differential equations from problems in context.	