**Quarter 1**

1. Review of Algebra/Trigonometry (covered first, although many review topics are embedded in the calculus curriculum as they appear).
   1. Functions: Definition, Finding domain, nonlinear inequalities and sign charts. [S 1.1]
   2. Composition of functions: Transformations, Computing compositions, Finding domains of composite functions, Inverse functions, one to one.
   3. Library of Functions (graphs and features, including zeros, asymptotes, and shape): power functions , where n is a positive integer, negative integer, and rational number between 0 and 1, Logarithmic functions, exponential functions, trigonometric functions.
   4. Exponential functions, Logarithms, properties of logarithms and exponents, and solving logarithmic and exponential equations.
   5. Review of basic trigonometry: values of trigonometric functions for common angles, finding and using reference angles, solving simple trigonometric equations such as  , inverse trigonometric functions with emphasis on the range values.
2. Limits and the Definition of the Derivative
   1. Introduction of the Difference Quotient: Discussion of slopes of lines, Average rate of change, and Average rate of change as an estimate of instantaneous rate of change, discussion of the concept of the limiting process.
   2. Definition of the Limit of a Function: Informal definition (not using ), graphical and numerical limits, algebraic limits involving 0/0, and using data tables.
   3. Explanation of Non-existence of the Limit of a Function: Graphical, numerical, and algebraic approaches, left-handed and right-handed limits, *graphing calculators are used to experiment with limits such as *.
   4. Continuity and the Limit Laws: Definition of continuity in three parts (existence of , existence of limit of at , and ), distinction between limit existing and continuity, implication of continuity for graphing, continuity on intervals—open and closed, using continuity to find limits, combining continuity with composition, removable discontinuities
   5. Limits Involving Infinity: --one-sided limits near asymptotes and the graphical behavior of a function near a vertical asymptote (NOTE: As many books generally disagree we only look at one-sided limits, although the textbook discusses two-sided limits equal to infinity, and there is a small distinction between when we say that a limit doesn’t exist because it is equal to infinity as opposed to looking at a limit equaling infinity to determine the graphical nature of a function),  and the graphical nature of functions near horizontal asymptotes, comparison of degrees in rational functions as a means to find horizontal asymptotes using limits, limits of polynomial functions, logarithmic functions, and exponential functions at and the implications—Intermediate Value Theorem.
   6. Definition of the Derivative as a Limit: Numerical, algebraic ways to find derivatives using limits, finding derivatives at a specific point, using average rates of change to estimate the derivatives given a table of data, alternate forms of the derivative such as , equations of tangent lines, *finding derivatives at a point using a graphing calculator*.
   7. The Derivative function: Finding derivative functions algebraically by using the limit definition of the difference quotient, Implications of positive, negative, and zero values of the derivative, nonexistence of the derivative and relationship to continuity (NOTE:  is used here because of the three ways to explain how a function can be continuous but not differentiable—1) analytically by looking at the slope of both linear pieces of the function, 2) by graphing the derivative and noticing a discontinuity at zero, 3) by algebraically taking the limit as a left-handed and right-handed limit.), vertical tangents such as in , cusps as in , intuitive proof that differentiable functions are continuous.
   8. Graphical Nature of the Derivative: Connecting relative extrema with zeros on the graph of , the second derivative and relationship to concavity, sketching the graph of  given the graph of *f*
   9. Analyzing the Graph of *f* Given the Graph of : Using the second derivative to identify concavity changes in addition to using the first derivative to identify extrema, noting the difference between concavity change and concavity change at a horizontal tangent.
   10. Verbal interpretation of the Derivative: Finding units of , identification of increasing/decreasing, describing a relationship between two variables given a value of the derivative at a point, distinction between  positive and  increasing (handout: “misery”, an article about how people misinterpret a negative sign for the second derivative as an indication that a function is decreasing)
3. Differentiation Rules
   1. Sum and Difference Rules, Constant Rules, Power Rule (proved using the limit definition).
   2. Product and Quotient Rules (proof of product rule, verification by viewing  via the power and product rules).
   3. Derivatives of Exponential and Trigonometric Functions (proof using limit definition with numerical evaluation of  , , and ), derivatives of other trigonometric functions using the product and quotient rules.
   4. The Chain Rule: No proof, but includes Leibniz notation, derivatives of  and inverse trigonometric functions using the chain rule, derivatives of inverse functions and the chain rule, problems involving chain and product/quotient rules.

**Quarter 2**

* 1. Derivatives of Functions of More than One Variable: Examples involving functions such as  and analysis of the sign of  and .
  2. Implicit Differentiation: Includes logarithmic differentiation, and functions of type , use in finding derivatives in inverse functions
  3. L’Hospital’s Rule: Indeterminate forms: a look at , discussion of , , and , introduction to the theorem of L’Hospital, *graphing calculators are used to verify the results of L’Hospital’s Rule*. Indeterminate power forms: , using the change of base formula to get limits in L’Hospital form, motivate why the forms are indeterminate, and evaluate the limits, *graphing calculators are used to verify the results of L’Hospital’s Rule*.

1. Applications of the Derivative
   1. Tangent Line Approximations: Computation of tangent line at a point, use of tangent line to approximate a value of a function, use of the second derivative to determine whether the tangent line will yield overestimates or underestimates, use of tangent lines with secant lines to locate intervals where *x* or *y*-values are located, *graphing calculators are used to demonstrate how a function can be approximated by a tangent line for x-values near the point of tangency*.
   2. Optimization (part 1): Extreme Value Theorem (Continuous functions attain their extrema on a closed interval), Fermat’s Theorem (If a function is differentiable, and has an extreme value at , then --proof by using the limit definition), finding critical points, finding absolute extrema, use of graphing calculator for finding zeros of the derivative.
   3. Optimization (part 2): First Derivative Test, Second Derivative Test, finding inflection points as a change in concavity, finding relative extrema, using tests and sign charts of and  to sketch the graph of *f*, monotonicity, use of graphing calculator for finding zeros of the derivative and second derivative, *graphing calculators are used to demonstrate the relevance to the zeros and signs of a derivative and second derivative to the original function*.
   4. Optimization (part 3): Optimization Word Problems: Objective/Constraint problems, rectilinear motion (position, velocity, speed, acceleration) problems, Geometric calculus applications.
   5. Related Rates: Typical related rates problems including problems involving trigonometry.

**Quarter 3**

1. Definition of the Integral
   1. Riemann sums (part 1): Introduction to a partition of an interval, and estimation of area using rectangles, left sum and right sum with intervals of irregular length, use on functions represented by data tables, use of programs or MAPLE to calculate Riemann sums with partitions of large size, *graphing calculator programs are used to calculate Riemann sums for large values of n*.
   2. Riemann sums (part 2): Other sums such as midpoint sum and trapezoid sum, representation of the trapezoid sum as the average of left and right sum, reliance of estimate for left and right sum on , reliance of estimate for midpoint and Trapezoid sum on , error bounds for left and right sums, use on functions represented by data tables, *graphing calculator programs are used to calculate trapezoid and midpoint sums for large values of n*.
   3. Definition of the definite integral: As , calculation of simple integrals by the definition.
   4. Properties of the definite integral: Area of whole is sum of the area of parts, positive and negative area, constant, sum, difference, and constant multiple properties, reversal of bounds, integral from a point to the same point, definite integrals as total change of a rate of change, getting distance from rates.
   5. Mean Value Theorem: Proof using Rolle’s Lemma.
   6. Definition of the antiderivative: Calculation of elementary antiderivatives (using functions whose derivative is known, indefinite integration, relation of antiderivative to area under a curve, Fundamental Lemma of Calculus:  is an antiderivative of .
   7. Fundamental Theorem of Calculus: Proof using the Mean Value Theorem, calculation of definite integrals, *use of graphing calculators to find definite integrals for functions without elementary antiderivatives*
   8. Integration by substitution (part 1): Easier substitution problems.
   9. Integration by substitution (part 2): More difficult substitution problems, powers of trigonometric functions, arctan problems, linear shifts, changing bounds for definite integrals.
2. Applications of Integration
   1. Region bounded by curves: Setting up as a definite integral, finding bounds, *finding intersection points and integration with a graphing calculator*.
   2. Interpretation of the Integral: Rectilinear motion problems (distance traveled as ), interpretation of integral as total accumulation of a function over an interval, using initial conditions with integration
   3. Volumes of Revolution (part 1): Disks and Washers, setting up formulas as limits of Riemann sums.
   4. Volumes of Revolution (part 2): Shells, setting up formulas as limits of Riemann sums.
   5. Volumes using Area of a Cross-section: Slicing, setting up formulas as limits of Riemann sums, AP style problems.
   6. Average Value of a Function: Relation to Mean Value Theorem, application problems.
   7. Differential Equations: Separable equations, link to implicit differentiation.
   8. Modeling with Differential equations: Exponential Growth/Decay, Newton’s Law of Heating/Cooling.
   9. Slope Fields: Graphing slope fields, using them to sketch solution curves, link to implicit differentiation for finding second derivative and critical thinking.

**Quarter 4**

1. Review for AP Exam
   1. Practice test to determine rough score/where students are.
   2. Repeated practice and evaluation of AP style questions, both calculator active and inactive, as well as multiple choice and free response.