**Calculus Syllabus**

**Centura Public School**

**Textbook: Calculus** Graphical, Numerical, Algebraic (3rd edition)

**Chapter 1 – Prerequisites for Calculus**

**Objectives:**

* 1. Lines: The student will be able to identify and work with increments, the slope of a line, parallel and perpendicular lines, and equations of lines, including application problems.

(Linear equations are used extensively in business and economic applications.)

* 1. Functions and Graphs: The student will be able to identify and work with functions, domains and ranges, viewing and interpreting graphs, symmetry (even and odd), piecewise functions, absolute value functions, and composite functions.

(Functions and graph form the basis for understanding mathematics and applications.)

* 1. Exponential Functions: The student will be able to identify and work with exponential growth, exponential decay, application problems and the number *e*.

(Exponential functions model many growth patterns.)

* 1. Functions and Logarithms: The student will be able to identify and work with one-to-one functions, inverses, finding inverses, logarithmic functions, properties of logarithms, and application problems.

(Logarithmic functions are used in many applications, including finding time in investment problems.)

* 1. Trigonometric Functions: The student will be able to identify and work with radian measure, graphs of trigonometric functions, periodicity, even and odd trigonometric functions, transformations of trigonometric graphs, and inverse trigonometric functions.

(Trigonometric functions can be used to model periodic behavior and applications such as musical notes.)

**Chapter 2 – Limits and Continuity**

**Objectives:**

2.1 Rates of Change and Limits: The student will be able to identify and work with average and instantaneous speed, definition of limit, properties of limits, one-sided and two-sided limits, and the Sandwich Theorem.

(Limits can be used to describe continuity, the derivative, and the integral: the ideas giving the foundation of calculus.)

2.2 Limits Involving Infinity: The student will be able to identify and work with finite limits as x approaches ∞ and -∞, the Sandwich Theorem again, infinite limits as x approaches a, end behavior models, and “seeing” limits as x approaches ∞ and

-∞.

(Limits can be used to describe the behavior of functions for numbers large in absolute value.)

2.3 Continuity: The student will be able to identify and work with continuity at a point, continuous functions, algebraic combinations, composites, and the Intermediate Value Theorem for Continuous Functions.

(Continuous functions are used to describe how a body moves through space and how the speed of a chemical reaction changes with time.)

2.4 Rates of Change and Tangent Lines: The student will be able to identify and work with average rates of change, tangent to a curve, slope of a curve, normal to a curve, and a revisit to speed.

(The tangent line determines the direction of a body’s motion at every point along its path.)

**Chapter 3 – Derivatives**

**Objectives:**

3.1 Derivative of a Function: The student will be able to identify and work with the definition of the derivative, notation, relationships between the graph of *f* and *f’*, graphing the derivative from data, and one-sided derivatives.

(The derivative gives the value of the slope of the tangent line to a curve at a point.)

3.2 Differentiability: The student will be able to identify and work with how *f’(a)* might fail to exist, differentiability implies local linearity, derivatives on a calculator, differentiability implies continuity, and the Intermediate Value Theorem for Derivatives.

(Graphs of differentiable functions can be approximated by their tangent lines at points where the derivative exists.)

3.3 Rules for Differentiation: The student will be able to identify and work with positive integer powers, multiples, sums and differences, products and quotients, negative integer powers of *x*, and second and higher order derivatives.

(These rules help us find derivatives of functions analytically more efficiently.)

3.4 Velocity and Other Rates of Change: The student will be able to identify and work with instantaneous rates of change, motion along a line, sensitivity to change, and derivatives in economics.

(Derivatives give the rates at which things change in the world.)

3.5 Derivatives of Trigonometric Functions: The student will be able to identify and work with derivatives of the sine function, derivative of the cosine function, simple harmonic motion, jerk, and derivatives of the other basic trigonometric functions.

(The derivatives of sines and cosines play a key role in describing periodic change.)

3.6 Chain Rule: The student will be able to identify and work with the derivative of a composite function, the “outside-inside” rule, the repeated use of the chain rule, the slopes of parametrized curves, and the Power Chain Rule.

(The Chain Rule is the most widely used differentiation rule in mathematics.)

3.7 Implicit Differentiation: The student will be able to identify and work with implicitly defined functions, lenses, tangents, and normal lines, derivatives of higher order, and rational powers of differentiable functions.

(Implicit differentiation allows us to find derivatives of functions that are not defined or written explicitly as a function of a single variable.)

3.8 Derivatives of Inverse Trigonometric Functions: The student will be able to identify and work with derivatives of inverse functions, derivative of the arcsine, derivative of the arctangent, derivative of the arcsecant, and derivatives of the other three.

(The relationship between the graph of a function and its inverse allows us to see the relationship between their derivatives.)

3.9 Derivatives of Exponential and Logarithmic Functions: The student will be able to identify and work with derivative of *ex*, derivative of *ax*, derivative of ln *x*, derivative of loga*x*, and the Power Rule for Arbitrary Real Powers.

(The relationship between exponential and logarithmic functions provides a powerful differentiation tool called logarithmic differentiation.)

**Chapter 4 – Applications of Derivatives**

**Objectives:**

4.1 Extreme Values of Functions: The student will be able to identify and work with absolute (global) extreme values, local (relative) extreme values, and finding extreme values.

(Finding maximum and minimum values of functions, called optimization, is an important issue in real-world problems.)

4.2 Mean Value Theorem: The student will be able to identify and work with the Mean Value Theorem, physical interpretation, increasing and decreasing functions, and other consequences.

(the Mean Value Theorem is an important theoretical tool to connect the average and instantaneous rates of change.)

4.3 Connecting *f’* and *f”* with the Graph of *f*: The student will be able to identify and work with the first derivative test for local extrema, concavity, points of inflection, the second derivative test for local extrema, and learning about functions from derivatives.

(Differential calculus is a powerful problem-solving tool precisely because of its usefulness for analyzing functions.)

4.4 Modeling and Optimization: The student will be able to identify and work with examples from mathematics, examples from business and industry, examples from economics, and modeling discrete phenomena with differentiable functions.

(Historically, optimization problems were among the earliest applications of what we now call differential calculus.)

4.5 Linearization and Newton’s Method: The student will be able to identify and work with linear approximation, Newton’s method, differentials, estimating change with differentials, absolute, relative, and percentage change, and sensitivity to change.

(Engineering and science depend on approximations in most practical applications; it is important to understand how approximation techniques work.)

4.6 Related Rates: The student will be able to identify and work with related rate equations, solution strategy, and simulating related motion.

(Related rate problems are at the heart of Newtonian mechanics; it was essentially to solve such problems that calculus was invented.)

**Chapter 5: The Definite Integral**

**Objectives:**

5.1 Estimating with Finite Sums: The student will be able to identify and work with distance traveled, rectangular approximation method, volume of a sphere, and cardiac output.

(Learning about estimating with finite sums sets the foundation for understanding integral calculus.)

5.2 Definite Integrals: The student will be able to identify and work with Riemann Sums, terminology and notation of integration, the definite integral, computing definite integrals on a calculator, and integrability.

(The definite integral is the basis of integral calculus, just as the derivative is the basis of differential calculus.)

5.3 Definite Integrals and Antiderivatives: The student will be able to identify and work with properties of definite integrals, average value of a function, Mean Value Theorem for Definite Integrals, and connecting differential and integral calculus.

(Working with the properties of definite integrals helps us to understand better the definite integral. Connecting derivatives and definite integrals sets the stage for the Fundamental Theorem of Calculus.)

5.4 Fundamental Theorem of Calculus: The student will be able to identify and work with Fundamental Theorem Part 1, graphing the function ∫f(t) dt, Fundamental Theorem Part 2, area connection, and analyzing antiderivatives graphically.

(The Fundamental Theorem of Calculus is a triumph of mathematical discovery and the key to solving many problems.)

5.5 Trapezoidal Rule: The student will be able to identify and work with trapezoidal approximations, other algorithms and error analysis.

(Some definite integrals are best found by numerical approximations, and rectangles are not always the most efficient figures to use.)