VALWOOD

GO BEYOND

Calculus Curriculum

Calculus Course Overview

Course Description

Calculus will reinforce students' skills in Algebra and Trigonoometry and provide students with an understanding of fundamental Calculus concepts. Students will begin with a review of the most important algebraic and trigonometric concepts to ensure a strong foundation. Students will then be introduces to the concepts of limits, derivatives, and integration. Two major concepts are tangent lines and area under the curve.

Topics at a Glance

- Circle and triangle representation of trigonometric functions
- Limits and rates of change
- Finding equation of a tangent line
- Derivatives
- Integration
- Area under a curve

Assessments

- Teacher Created Assessments
- Assessments adopted from course materials

Grade Level Expectations

Standard	Big Ideas for Calculus
1. Number Sense, properties, and Operations	1. The complex number system includes real numbers and imaginary numbers 2. Quantitative reasoning is used to make sense of quantities and their relationships in problem situations
2. Patterns, Functions, & Algebraic Structures	1. Functions model situations where one quantity determines another and can be represented algebraically, graphically, and using tables 2. Quantitative relationships in the real world can be modeled and solved using functions 3. Solutions to equations, inequalities and systems of equations are found using a variety of tools
3. Data Analysis, Statistics & Probability	
4. Shape, Dimension, & Geometric Relationships	1. Fundamental understanding of circular trigonometry can be used in many applications 2. Objects in the plane can be described and analyzed algebraically 3. Objects in the real world can be modeled using geometric concepts

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

1. Number Sense, Properties, and Operations

Number sense provides students with a firm foundation in mathematics. Students build a deep understanding of quantity, ways of representing numbers, relationships among numbers, and number systems. Students learn that numbers are governed by properties, and understanding these properties leads to fluency with operations.

Valwood Graduates

The Valwood graduate competencies are the preschool through twelfth-grade concepts and skills that all students who complete the education system must master to ensure their success in a postsecondary and workforce setting.

Valwood Graduate Competencies in the Number Sense, Properties, and Operations Standard are:

- Understand the structure and properties of our number system. At their most basic level numbers are abstract symbols that represent real-world quantities
- Understand quantity through estimation, precision, order of magnitude, and comparison. The reasonableness of answers relies on the ability to judge appropriateness, compare, estimate, and analyze error
- Are fluent with basic numerical and symbolic facts and algorithms, and are able to select and use appropriate (mental math, paper and pencil, and technology) methods based on an understanding of their efficiency, precision, and transparency
- Make both relative (multiplicative) and absolute (arithmetic) comparisons between quantities. Multiplicative thinking underlies proportional reasoning
- Understand that equivalence is a foundation of mathematics represented in numbers, shapes, measures, expressions, and equations
- Apply transformation to numbers, shapes, functional representations, and data

Content Area: Mathematics - Calculus

Standard: 1. Number Sense, Properties, and Operations

Valwood Graduates:

Understand the structure and properties of our number system. At their most basic level numbers are abstract symbols that represent real-world quantities.

GRADE LEVEL EXPECTATION

Concepts and skills students master:

1. Perform operations with polar coordinates.

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Locate and apply polar coordinates in i. Polar graphs ii. Polar area iii. Arc length iv. Surface area	**Inquiry Questions:** 1. When should you choose to use polar coordinates? 2. How are polar coordinates a unique combination of trigonometry, Euclidean Geometry, Cartesian Rectangular Algebra, Differential Calculus and Parametric Equations? 3. Polar coordinates were developed historically to meet a specific mathematical need. What other mathematical concepts were developed to meet an immediate need for problem solving?
	Relevance and Application: 1. Astronomers developed methods for approximating and calculating the direction to and its distance from any location on the Earth. 2. Bernoulli's work extended to finding the radius of curvature of curves expressed in these coordinates. 3. Angles in polar notation are generally expressed in either degrees or radians (2π rad being equal to 360°). Degrees are traditionally used in navigation, surveying, and many applied disciplines, while radians are more common in mathematics and mathematical physics.[9] 4. Because of the circular nature of the polar coordinate system, many curves can be described by a rather simple polar equation, whereas their Cartesian form is much more intricate. Among the best known of these curves are the polar rose, Archimedean spiral,lemniscate, limaçon, and cardioid. 5. Conic sections designed with polar coordinates are often used in graphic design and mechanical engineering.
	Nature of Discipline: 1. Mathematicians reason abstractly and quantitatively. 2. Mathematicians model with mathematics. 3. Mathematicians use appropriate tools strategically.

2. Patterns, Functions, and Algebraic Structures

Pattern sense gives students a lens with which to understand trends and commonalities. Being a student of mathematics involves recognizing and representing mathematical relationships and analyzing change. Students learn that the structures of algebra allow complex ideas to be expressed succinctly.

Valwood Graduate Competencies
The Valwood graduate competencies are the preschool through twelfth-grade concepts and skills that all graduates will be able to demonstrate.

Valwood Graduate Competencies. Patterns, Functions, and Algebraic Structures Standard are:

- Are fluent with basic numerical and symbolic facts and algorithms, and are able to select and use appropriate (mental math, paper and pencil, and technology) methods based on an understanding of their efficiency, precision, and transparency
- Understand that equivalence is a foundation of mathematics represented in numbers, shapes, measures, expressions, and equations
- Make sound predictions and generalizations based on patterns and relationships that arise from numbers, shapes, symbols, and data
- Make claims about relationships among numbers, shapes, symbols, and data and defend those claims by relying on the properties that are the structure of mathematics
- Use critical thinking to recognize problematic aspects of situations, create mathematical models, and present and defend solutions

Content Area: Mathematics - Calculus

Standard: 2: Patterns, Functions, and Algebraic Structures

Valwood Graduates:

Are fluent with basic numerical and symbolic facts and algorithms, and are able to select and use appropriate (mental math, paper and pencil, and technology) methods based on an understanding of their efficiency, precision, and transparency

Use critical thinking to recognize problematic aspects of situations, create mathematical models, and present and defend solutions

GRADE LEVEL EXPECTATION:

Concepts and skills students master:

1. Solve problems using multiple techniques for differentiation and integration. Apply integration to real world problems.

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Integrate and differentiate logarithmic and exponential functions using appropriate techniques. b. Determine the most appropriate method for integration and evaluate integrals using various integration techniques. 1. Integration by parts 2. Trigonometric integrals 3. Trigonometric substitution. 4. Partial fractions 5. Tables 6. Technology c. Evaluate improper integrals d. Find density and mass of a straight wire with a variable mass distribution. e. Find work done by a variable force 1. Lifting variable masses 2. Hooke's law 3. Pumping liquids f. Find fluid pressure and fluid forces.	**Inquiry Questions:** 1. When is a particular technique the most appropriate for a problem? 2. How can calculus be applied to real world problems? 3. How do you model a physical situation with mathematics? **Relevance and Application:** 1. Integration is used in many areas of quantum mechanics, statistics, polymer physics, and financial markets.[1] 2. Work and force are central topics in physics. 3. Integrals are used to calculate total change in speed, distance, solid and liquid volume and other quantities. 4. Finding the volume of the cross-section of a three-dimensional object whose dimensions are defined by a function is used in designing and systematically manufacturing many of the products we use every day. **Nature of Discipline:** 1. Make sense of problems and persevere in solving them. 2. Use appropriate tools strategically. 3. Attend to precision. 4. Mathematics involves visualization. 5. Mathematicians use models to better understand systems and make predictions about future systemic behavior. 6. Mathematicians model with mathematics.

Content Area: Mathematics - Calculus

Standard: 2: Patterns, Functions, and Algebraic Structures

Valwood Graduates:

Understand that equivalence is a foundation of mathematics represented in numbers, shapes, measures, expressions, and equations

GRADE LEVEL EXPECTATION: Calculus

Concepts and skills students master:

2. Computation and application of differential and parametric equations allow us to model real-world situations.

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Recognize and solve differential equations. 1. Separable equations i. Exponential growth and decay ii. Logistic equation 2. First order linear differential equations b. Use slope fields to represent solutions to differential equations. c. Represent functions using parametric equations. d. Apply integration and differentiation to parametric equations.	**Inquiry Questions:** 1. How does one type of differential equation differ from another? 2. Why would parametric equations be a good choice to model a situation? **Relevance and Application:** 1. Differential equations model electrical circuits, radioactivity, population growth and many other physical situations. 2. Parametric equations model motion in a gravitational field. **Nature of Discipline:** 1. Mathematicians use appropriate tools strategically. 2. Mathematicians use their knowledge of functions to create accurate models of complex systems. 3. Mathematicians use models to better understand systems and make predictions about future systemic behavior. 4. Mathematicians model with mathematics. 5. Mathematicians abstract a problem by representing it as an equation. They travel between the concrete problem and the abstraction to gain insights and find solutions.

Content Area: Mathematics - Calculus

Standard: 2: Patterns, Functions, and Algebraic Structures

Valwood Graduates:

Make sound predictions and generalizations based on patterns and relationships that arise from numbers, shapes, symbols, and data
Communicate effective logical arguments using mathematical justification and proof. Mathematical argumentation involves making and testing conjectures, drawing valid conclusions, and justifying thinking
Make claims about relationships among numbers, shapes, symbols, and data and defend those claims by relying on the properties that are the structure of mathematics

GRADE LEVEL EXPECTATION:

Concepts and skills students master:

3. Infinite sequences and series.

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Choose the appropriate test and determine convergence or divergence of sequences and series. 1. Geometric series 2. telescoping series 3. integral test 4. p-series 5. direct comparison 6. limit comparison test 7. alternating series test i. absolute and conditional convergence 8. ratio test 9. root test b. Approximate functions with polynomials 1. Taylor and Maclaurin series 2. Power series i. Radius and interval of convergence ii. Integration and differentiation c. Represent functions using geometric power series. d. Use properties of power series along with differentiation and integration to develop power series for a variety of functions.	**Inquiry Questions:** 1. How do you decide which convergence test is the most appropriate? 2. Why would representing a function as a polynomial be desirable? **Relevance and Application:** 1. Series can represent compound interest and depreciation. 2. Taylor series can be used to write algorithms for computers to compute with complicated functions. **Nature of Discipline:** 1. Mathematicians use appropriate tools strategically. 2. Mathematicians use models to better understand systems and make predictions about future systemic behavior. 3. Mathematicians model with mathematics.

3. Data Analysis, Statistics, and Probability

Data and probability sense provides students with tools to understand information and uncertainty. Students ask questions and gather and use data to answer them. Students use a variety of data analysis and statistics strategies to analyze, develop and evaluate inferences based on data. Probability provides the foundation for collecting, describing, and interpreting data.

Valwood Graduate Competencies
The Valwood graduate competencies are the preschool through twelfth-grade concepts and skills that all graduates will be able to demonstrate.

Valwood Graduate Competencies. Data Analysis, Statistics, and Probability Standard are:

- Recognize and make sense of the many ways that variability, chance, and randomness appear in a variety of contexts
- Solve problems and make decisions that depend on understanding, explaining, and quantifying the variability in data
- Communicate effective logical arguments using mathematical justification and proof. Mathematical argumentation involves making and testing conjectures, drawing valid conclusions, and justifying thinking
- Use critical thinking to recognize problematic aspects of situations, create mathematical models, and present and defend solutions

4. Shape, Dimension, and Geometric Relationships

Geometric sense allows students to comprehend space and shape. Students analyze the characteristics and relationships of shapes and structures, engage in logical reasoning, and use tools and techniques to determine measurement. Students learn that geometry and measurement are useful in representing and solving problems in the real world as well as in mathematics.

Valwood Graduate Competencies
The Valwood graduate competencies are the preschool through twelfth-grade concepts and skills that all graduates will be able to demonstrate.

Shape, Dimension, and Geometric Relationships standard are:

- Understand quantity through estimation, precision, order of magnitude, and comparison. The reasonableness of answers relies on the ability to judge appropriateness, compare, estimate, and analyze error
- Make sound predictions and generalizations based on patterns and relationships that arise from numbers, shapes, symbols, and data
- Apply transformation to numbers, shapes, functional representations, and data
- Make claims about relationships among numbers, shapes, symbols, and data and defend those claims by relying on the properties that are the structure of mathematics
- Use critical thinking to recognize problematic aspects of situations, create mathematical models, and present and defend solutions

Content Area: Mathematics - Calculus

Standard: 4. Shape, Dimension, and Geometric Relationships

Valwood Graduates:

Use critical thinking to recognize problematic aspects of situations, create mathematical models, and present and defend solutions

GRADE LEVEL EXPECTATION:

Concepts and skills students master:

1. Integration can be used to find length of curves, area and volume of solids of revolution.

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Find the area between two curves. b. Find arc length of a curve. c. Find the surface area of a surface of revolution. d. Find the volume of a solid of revolution using the most appropriate method. 1. Disk method 2. Shell method	**Inquiry Questions:** 1. What assumptions do we make in order to apply integration to surface area and volume problems? 2. How are integral for finding surface area and volume of a three-dimensional object combined with computer programming to create manufacturing programs used in companies all over the world? 3. How do we determine when to use the Shell method over the Disk method? How can being confident in this determination make us more efficient and effective mathematicians?
	Relevance and Application: 1. Solids of revolution are used to model real world objects like light bulbs, aircraft fuselages and containers.
	Nature of Discipline: 1. Mathematics involves visualization. 2. Mathematicians use appropriate tools strategically. 3. Mathematicians model with mathematics.