LIVE Online Math Calculus Scope and Sequence

The course is broken down into units. The units, and lessons that make up each unit, are below.
<mark>Note: If there is a specific concept/technique that is not listed, please <u>contact us</u> to see if it is part of the course. Specific content is not always readily identifiable simply from the title of a lesson.</mark>

Unit 1: Review of Functions and Pre-Calculus

The goal of Unit 1 is to review a variety of functions encountered in Pre-Calculus and Algebra II. Since many of the Calculus concepts will build upon the characteristics of these functions, having a good foundation is necessary for success. The functions covered in this unit include polynomials, rational, trigonometric, logarithmic, and exponential functions, as well as the transformations of these functions.

Lesson 1: Function Review

Lesson 2: Transformations of Functions

Lesson 3: Polynomial Functions

Lesson 4: Rational Functions

Lesson 5: Logarithmic and Exponential Functions

Lesson 6: Trigonometric Functions

Lesson 7: Piecewise Functions and Discontinuities Basics

Unit 2: Limits

Unit 2 marks the beginning of true Calculus content, and it is here we lay the foundation for understanding the derivative and integral. In Unit 2, students will encounter, for the first time the concepts of instantaneous rates of change, discontinuity, infinitely approaching given values of a function, and how that function behaves accordingly. Students will also be introduced to the first set of formal Calculus theorems and rules.

Lesson 1: Tangent Lines, Secant Lines, and Average Velocity

Lesson 2: Definition of a Limit and How to Evaluate Them

Lesson 3: Overall, One-Sided, and Infinite Limits

Lesson 4: Limit Laws

Lesson 5: Special Cases of Limits and the Squeeze Theorem

Lesson 6: Continuity, Discontinuity, and the Intermediate Value Theorem

Unit 3: Properties and Rules of Derivatives

In Unit 3 students begin their study of the derivative, the first of two major topics of Calculus. Building upon the concepts of the limit, students will learn the definition of a derivative and its connection to rate of change. This unit will also teach students some of the key properties and rules for finding the derivative of a function. Differentiation rules are also emphasized in this unit.

Lesson 1: Introduction to the Derivative and Limit Definition of a Derivative

Lesson 2: Derivatives of a Function

Lesson 3: Graphs of Derivatives, Differentiability, and Continuity

Lesson 4: Differentiation Rules – Constant, Power, Sum, and Difference

Lesson 5: Differentiation Rules – Product and Quotient

Lesson 6: Applications of Derivatives

Unit 4: Derivatives of Functions and Other Techniques

Continuing to explore the world of derivatives, in Unit 4, students will be encounter more complex functions and their derivatives. These will include trigonometric, logarithmic, and exponential functions. Additional techniques for finding derivatives and finding higher order derivatives will also be covered in this unit.

Lesson 1: Derivative of Trigonometric Functions

Lesson 2: Derivative of Exponential and Logarithmic Functions

Lesson 3: The Chain Rule

Lesson 4: Derivative of Inverse Functions and Inverse Trigonometric Functions

Lesson 5: Implicit Differentiation

Lesson 6: Related Rates

Unit 5: Applications of Derivatives

Here students will be able to apply what they have learned about the derivative to real world applications. Unit 5 will guide students through applying the derivative to function analysis, approximation, optimization, related rate, and other formal theorems of Calculus.

Lesson 1: Extreme Value Theorem, Mean Value Theorem, and Rolle's Theorem

Lesson 2: The First Derivative Test

Lesson 3: The Second Derivative Test

Lesson 4: Linear Approximation and Differentials

Lesson 5: Optimization

Lesson 6: L'Hopital's Rule

Unit 6: Properties and Rules of the Integral

Integration is the second primary topic taught in Calculus, and Unit 6 introduces this concept. This unit begins with the method for approximating area using rectangles, and then extends that to an infinite number of rectangles with Reimann Sums. Students are then given the definition of an integral which leads to the Fundamental Theorem of Calculus. The second half of the unit focuses on the basic rules of integration and techniques for finding the integral of special functions.

Lesson 1: Approximating Area Under a Curve and Reimann Sums

Lesson 2: The Definite Integral with Reimann Sums

Lesson 3: Antiderivatives, Definite Integrals, and Indefinite Integrals

Lesson 4: The Fundamental Theorem of Calculus

Lesson 5: Substitution

Lesson 6: Integrals Resulting in Inverse Trigonometric Functions

Unit 7: Applications of Integrals

Unit 7 is where students will cover some of the applications of integrals. The primary application that is focused on is finding volumes of a solid using different techniques of integration. These techniques include the disk, washer, and shell methods. Students will also learn how to find the arc length of a function and surface area of a solid defined by a given function.

Lesson 1: Area Between Curves

Lesson 2: Volumes of a Solid by Slicing

Lesson 3: Volumes of Revolution – Disk Method

Lesson 4: Volumes of Revolution – Washer Method

Lesson 5: Volumes of Revolution – Shell Method

Lesson 6: Arc Length of a Curve and Surface Area

Unit 8: Techniques of Integration

Unit 8 is the final unit dedicated to integration. In this unit a variety of useful techniques of integration are covered. These include integration by part, trigonometric techniques, partial fraction decomposition, improper integrals, and a brief discussion of integral tables. Unit 8 also aims to strengthen students' integration and problem-solving skills.

Lesson 1: Integration by Part

Lesson 2: Trigonometric Integral

Lesson 3: Trigonometric Substitution

Lesson 4: Partial Fractions

Lesson 5: Improper Integrals

Lesson 6: Integral Tables

Unit 9: Introduction to Differential Equations

An extension of the Calculus progression is differential equations and their applications. In Unit 9 students will be introduced to differential equations, the basic types of differential equations, and how to solve them. Direction Fields will also be briefly discussed in Unit 9.

Lesson 1: Basics of Differential Equations

Lesson 2: Initial Value Problems

Lesson 3: Separable Equations

Lesson 4: First-Order Linear Equations

Lesson 5: Direction Fields

Unit 10: Sequences and Series

Students will dive deeper into sequences and series in Unit 10. Here students are reintroduced to the concepts of a sequence and series and their similarities and differences. The topic of a sequence will then be widened by discussing divergent and convergent series. The second half of Unit 10 is dedicated to several of the tests used to determine if a series is divergent or convergent.

Lesson 1: Sequences

Lesson 2: Convergence and Divergence of a Sequence

Lesson 3: Series

Lesson 4: Arithmetic, Geometric, Harmonic, and *p*-series Tests

Lesson 5: Divergence and Integral Tests

Lesson 6: Comparison Test and Limit Comparison Test

Lesson 7: Alternating Series Test

Lesson 8: Ratio Test and Root Test

Miscellaneous Content

Miscellaneous content will be sprinkled into the course at various times. Some of that potential content is listed below.

• Power Series

• Moments and Centers of Mass

• Newton's Method

• Logarithmic Differentiation