## Quarter 2 — Calculus

| Quarter 1 | | Quarter 2 | | Quarter 3 | | Quarter 4 |
|---|---|---|---|---|---|---|
| Preparation for Calculus, Limits and Their Properties, Differentiation | | Differentiation (continued from Quarter 1), Logarithmic, Exponential, and Other Transcendental Functions | | Applications of Differentiation, Integration | | Logarithmic, Exponential, and Other Transcendental Functions, Differential Equations, Applications of Integration |
| August 12, 2019 – October 11, 2019 | | October 21, 2019 – December 20, 2019 | | January 6, 2020 – March 13, 2020 | | March 23, 2020 – May 22, 2020 |
| C.F.LF.A.1 | C.D.CD.B.6 | C.D.AD.A.2 | C.D.CD.B.6 | C.D.AD.B.7 | C.I.UI.B.7 | C.I.UI.A.1 |
| C.F.LF.A.2 | C.D.CD.B.7 | C.D.AD.A.4 | C.D.CD.B.8 | C.D.AD.B.8 | C.I.AI.A.1 | C.I.UI.A.2 |
| C.F.LF.A.3 | C.D.AD. A.1 | C.D.AD.A.5 | | C.D.AD.B.9 | C.I.AI.A.2 | C.I.UI.A.3 |
| C.F.BF.A.1 | C.D.AD. A.2 | C.D.AD.A.6 | | C.D.AD.B.10 | C.I.AI.A.3 | C.I.UI.B.5 |
| C.F.BF.A.2 | C.D.AD. A.3 | C.D.AD.B.7 | | C.D.AD.B.11 | | C.I.UI.B.6 |
| C.F.C.A.1 | | C.D.AD.B.8 | | C.D.AD.B.12 | | C.I.UI.B.7 |
| C.F.C.A.2 | | C.D.AD.B.9 | | C.D.AD.C.16 | | C.I.AI.A.1 |
| C.F.C.A.3 | | C.D.AD.B.10 | | C.D.AD.C.18 | | C.I.AI.A.2 |
| C.F.C.A.4 | | C.D.AD.B.11 | | C.I.UI.A.1 | | C.I.AI.A.3 |
| C.D.CD.A.1 | | C.D.AD.B.12 | | C.I.UI.A.2 | | C.I.AI.B.4 |
| C.D.CD.A.2 | | C.D.AD.B.13 | | C.I.UI.A.3 | | C.I.AI.B.5 |
| C.D.CD.A.3 | | C.D.AD.C.15 | | C.I.UI.B.4 | | C.I.AI.B.6 |
| C.D.CD.A.4 | | C.D.AD.C.17 | | C.I.UI.B.5 | | |
| C.D.CD.B.5 | | C.D.CD.B.5 | | C.I.UI.B.6 | | |

## Introduction

Destination 2025, Shelby County Schools' 10-year strategic plan, is designed not only to improve the quality of public education, but also to create a more knowledgeable, productive workforce and ultimately benefit our entire community.

### What will success look like?


In order to achieve these ambitious goals, we must collectively work to provide our students with high quality, college and career ready aligned instruction. The Tennessee State Standards provide a common set of expectations for what students will know and be able to do at the end of a grade. The State of Tennessee provides two sets of standards, which include the Standards for Mathematical Content and The Standards for Mathematical Practice. The Content Standards set high expectations for all students to ensure that Tennessee graduates are prepared to meet the rigorous demands of mathematical understanding for college and career. The eight Standards for Mathematical Practice describe the varieties of expertise, habits of mind, and productive dispositions that educators seek to develop in all students. The Tennessee State Standards also represent three fundamental shifts in mathematics instruction: **focus, coherence and rigor**.


Throughout this curriculum map, you will see resources as well as links to tasks that will support you in ensuring that students are able to reach the demands of the standards in your classroom. In addition to the resources embedded in the map, there are some high-leverage resources around the content standards and mathematical practice standards that teachers should consistently access. For a full description of each, click on the links below.

# How to Use the Maps

**Overview**
An overview is provided for each quarter and includes the topics, focus standards, intended rigor of the standards and foundational skills needed for success of those standards.

**Your curriculum map contains four columns that each highlight specific instructional components. Use the details below as a guide for information included in each column.**

**Tennessee State Standards**
TN State Standards are located in the left column. Each content standard is identified as Major Content or Supporting Content (for Algebra I, Algebra II & Geometry only). A key can be found at the bottom of the map.

**Content**
This section contains learning objectives based upon the TN State Standards. Best practices tell us that clearly communicating measurable objectives lead to greater student understanding. Additionally, essential questions are provided to guide student exploration and inquiry.

**Instructional Support & Resources**
District and web-based resources have been provided in the Instructional Support & Resources columns. You will find a variety of instructional resources that align with the content standards. The additional resources provided should be used as needed for content support and scaffolding. The inclusion of vocabulary serves as a resource for teacher planning and for building a common language across K-12 mathematics. One of the goals for Tennessee State Standards is to create a common language, and the expectation is that teachers will embed this language throughout their daily lessons.

## Topics Addressed in Quarter 2

- **Differentiation (continued from Quarter 1)**
- **Logarithmic, Exponential, and Other Transcendental Functions**

## Overview

Students continue their work with differentiation, which started in Quarter 1. These concepts include the product and quotient rules, higher order derivatives, the chain rule and implicit differentiation. Students also study logarithmic, inverse, inverse trigonometric and exponential functions. The quarter concludes with the study of rates of change, including related rates problems; problems involving minima/maxima; understanding and finding extrema; Rolle's Theorem and the Mean Value Theorem; increasing and decreasing functions and the first derivative test; and finally concavity and the second derivative test.

| TN State Standards | Content | Instructional Support & Resources | |
|---|---|---|---|
| **Chapter 2: Differentiation (continued)**<br>**(Allow approximately 3 weeks for instruction, review, and assessment)** | | | |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply differentiation techniques<br>**C.D.AD.A.2**<br>Calculate the derivative of basic functions (power, exponential, logarithmic, and trigonometric). | **Essential Questions:**<br>• In what types of problems do the various differentiation rules apply?<br>• How can a function be transformed prior to differentiation in to apply a simpler differentiation rule?<br>• How can derivatives be applied to solving motion problems?<br>**Objectives:**<br>Students will:<br>• Find the derivative of a function using the Product Rule.<br>• Find the derivative of a function using the Quotient Rule.<br>• Find the derivative of a trigonometric function. | 2.3: Product and Quotient Rules and Higher-Order Derivatives<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Product Rule<br>Quotient Rule<br>Larson Calculus Videos – Section 2.3<br>Calculus Tutorial Videos<br>Calculus Activities Using the TI-84 | **Chapter 2 Vocabulary:**<br>Tangent line, position, velocity, acceleration, average rate of change, instantaneous rate of change, derivative, differentiable, constant rule, power rule, sum rule, constant multiple rule, logarithmic rule, exponential rule, product rule, quotient rule, chain rule, trigonometric rules, inverse trigonometric rule, implicit differentiation, chain rule, higher order derivatives, orthogonal, linear approximation, linearization, differentials<br><br>**Writing in Math**<br>Sketch the graph of a differentiable function $f$ such that $f(2) = 0$, $f' < 0$ for $-\infty < x < 2$, and $f' > 0$ for $2 < x < \infty$. Explain how you found your answer. |

| TN State Standards | Content | Instructional Support & Resources | |
|---|---|---|---|
| | • Find a higher-order derivative of a function. | | |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply differentiation techniques<br><br>**C.D.AD.A.4**<br>Apply the chain rule to find the derivative of a composite function. | **Objectives:**<br>Students will:<br>• Find the derivative of a composite function using the Chain Rule.<br>• Find the derivative of a function using the general Power Rule.<br>• Simplify the derivative of a function using algebra.<br>• Find the derivative of a trigonometric function using the Chain Rule. | 2.4: The Chain Rule<br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 2.4<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos<br>Calculus Activities Using the TI-84 | **Writing in Math**<br>In the following, the relationship between *f* and *g* is given. Explain the relationship between *f* ' and *g* '.<br>✓ $g(x) = f(3x)$<br>✓ $g(x) = f(x^2)$ |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply differentiation techniques<br>**C.D.AD.A.5**<br>Implicitly differentiate an equation in two or more variables. | **Objectives:**<br>Students will:<br>• Distinguish between functions written in implicit form and explicit form.<br>• Use implicit differentiation to find the derivative of a function. | 2.5: Implicit Differentiation<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 2.5<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos<br>Calculus Activities Using the TI-84 | **Writing in Math**<br>Describe the difference between the explicit form of a function and an implicit equation. Give an example of each.<br><br>In your own words state the guidelines for implicit differentiation. |
| **Chapter 5: Logarithmic, Exponential, and Other Transcendental Functions**<br>**(Allow approximately 3 weeks for instruction, review, and assessment)** | | | |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply differentiation techniques<br>**C.D.AD.A.2**<br>Calculate the derivative of basic functions (power, exponential, logarithmic, and trigonometric). | **Essential Question(s)**<br>• How do derivatives apply to the world around us and how can we use them to understand unknown functions?<br>• How can we find a precise rate of change at a given instant?<br>• How do we describe how the rate of change changes?<br>• In what types of problems do the various differentiation rules apply? | 5.1: The Natural Logarithmic Function<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 5.1<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos<br>Calculus Activities Using the TI-84 | **Chapter 5 Vocabulary:**<br>Natural logarithmic function, base for the natural logarithm, inverse function, refection, horizontal line test, base, exponential function, inverse secant function, inverse trigonometric functions, elementary function, hyperbolic functions<br><br>**Writing in Math**<br>How can differential equations be used to |

| TN State Standards | Content | Instructional Support & Resources | |
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| | • How can derivatives be applied to solving motion problems?<br>**Objectives:**<br>Students will:<br>• Develop and use properties of the natural logarithmic function.<br>• Understand the definition of the number *e*.<br>• Find the derivatives of functions involving the natural logarithmic function. | | model real world problems?<br><br>What information do the first and second derivatives of a function give about the function itself? |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply differentiation techniques<br>**C.D.AD.A.6**<br>Use implicit differentiation to find the derivative of the inverse of a function. | **Objectives:**<br>Students will:<br>• Verify that one function is the inverse function of another function.<br>• Determine whether a function has an inverse function.<br>• Find the derivative of an inverse function. | 5.3: Inverse Functions<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 5.3<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos<br>Calculus Activities Using the TI-84 | **Writing in Math**<br>Describe how to find the inverse function of a one-to-one function given by an equation in *x* and *y*. Give an example.<br><br>Describe the relationship between the graph of a function and the graph of its inverse function. |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply differentiation techniques<br>**C.D.AD.A.6**<br>Use implicit differentiation to find the derivative of the inverse of a function. | **Objectives:**<br>Students will:<br>• Develop properties of the six inverse trigonometric functions.<br>• Differentiate an inverse trigonometric function. | 5.6: Inverse Trigonometric Functions: Differentiation<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 5.6<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos<br>Calculus Activities Using the TI-84 | **Writing in Math**<br>• How do you find the derivative of a trigonometric function?<br>• What role do inverse trigonometric and hyperbolic functions play in calculus?<br>• How can you approximate solutions to differential equations numerically? |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply differentiation techniques<br>**C.D.AD.A.2**<br>Calculate the derivative of basic functions (power, exponential, logarithmic, and | **Objectives:**<br>Students will:<br>• Develop properties of the natural exponential function. | 5.4: Exponential Functions: Differentiation and Integration<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 5.4 | |

| TN State Standards | Content | Instructional Support & Resources | |
|---|---|---|---|
| trigonometric). | • Differentiate natural exponential functions. | Calculus Tutorial Videos<br>Khan Academy Calculus Videos<br>Calculus Activities Using the TI-84 | |
| **Chapter 2: Differentiation**<br>**Chapter 3: Applications of Differentiation**<br>**(Allow approximately 3 weeks for instruction, review, and assessment)** | | | |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Apply derivatives to solve problems<br>**C.D.AD.C.15**<br>Model rates of change, including related rates problems. In each case, include a discussion of units.<br>**C.D.AD.C.17**<br>Use differentiation to solve problems involving velocity, speed, and acceleration.<br><br>**Domain**: Understand the Concept of a Derivative<br>**Cluster**: Understand the derivative at a point<br>**C.D.CD.B.5**<br>Interpret the derivative as the slope of a curve (which could be a line) at a point, including points at which there are vertical tangents and points at which there are no tangents (i.e., where a function is not locally linear).<br><br>**C.D.CD.B.6**<br>Approximate both the instantaneous rate of change and the average rate of change given a graph or table of values. | **Essential Question(s)**<br>• How do derivatives apply to the world around us and how can we use them to understand unknown functions?<br>• How can we find a precise rate of change at a given instant?<br>• How do we describe how the rate of change changes?<br>• In what types of problems do the various differentiation rules apply?<br>• How can derivatives be applied to solving motion problems?<br>**Objectives:**<br>Students will:<br>• Model rates of change, including related rates problems.<br>• Set up and solve related rates problems including minima/maxima. Where applicable, solve both symbolically and graphically. | 2.6: Related Rates<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 2.6<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos | **Writing in Math**<br>How are derivatives related to rates of change?<br><br>In your own words, state the guidelines for solving related rate problems. |

| TN State Standards | Content | Instructional Support & Resources | |
|---|---|---|---|
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Use first and second derivatives to analyze a function<br>**C.D.AD.B.8**<br>Use the first derivative to find extrema (local and global). | **Objectives:**<br>Students will:<br>• Understand the definition of extrema of a function on an interval.<br>• Understand the definition of relative extrema of a function on an open interval.<br>• Find extrema on a closed interval. | 3.1: Extrema on an Interval<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 3.1<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos | **Chapter 3 Vocabulary (3-1 through 3-4):**<br>Extrema (extreme values), absolute minimum, absolute maximum, global minimum, global maximum, relative maximum, relative minimum, critical number, Rolle's Theorem, Mean Value Theorem, increasing and decreasing functions, strictly monotonic, concavity, point of inflection<br><br>**Writing in Math**<br>List the four steps to find the extrema of a continuous function *f* on a closed interval [a, b]. |
| **Domain**: Understand the Concept of a Derivative<br>**Cluster**: Understand the derivative at a point<br>**C.D.CD.B.8**<br>Apply the Mean Value Theorem.<br>**C.D.AD.B.9**<br>Understand Rolle's Theorem as a special case of the Mean Value Theorem. | **Objectives:**<br>Students will:<br>• Understand and use Rolle's Theorem.<br>• Understand and use the Mean Value Theorem. | 3.2: Rolle's Theorem and the Mean Value Theorem<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 3.2<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos | **Writing in Math**<br>Let *f* be continuous on [a, b] and differentiable on (a, b). If there exists *c* in (a, b) such that *f* '(c) = 0, does it follow that *f*(a) = *f* (b)? Explain. |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Use first and second derivatives to analyze a function<br>**C.D.AD.B.7**<br>Relate the increasing and decreasing behavior of *f* to the sign of *f'* both analytically and graphically.<br>**C.D.AD.B.8**<br>Use the first derivative to find extrema (local and global). | **Objectives:**<br>Students will:<br>• Determine intervals on which a function is increasing or decreasing.<br>• Apply the First Derivative Test to find relative extrema of a function. | 3.3: Increasing and Decreasing Functions and the First Derivative Test<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 3.3<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos<br>BrightStorm: Increase and Decrease | **Writing in Math**<br>How do the graphs of the first and second derivatives relate to the function graph? |

| TN State Standards | Content | Instructional Support & Resources | |
|---|---|---|---|
| **C.D.AD.B.9**<br>Analytically locate the intervals on which a function is increasing, decreasing, or neither. | | | |
| **Domain**: Computing and Applying Derivatives<br>**Cluster**: Use first and second derivatives to analyze a function<br>**C.D.AD.B.7**<br>Relate the increasing and decreasing behavior of *f* to the sign of *f'* both analytically and graphically.<br>**C.D.AD.B.10**<br>Relate the concavity of *f* to the sign of *f"* both analytically and graphically.<br>**C.D.AD.B.11**<br>Use the second derivative to find points of inflection as points where concavity changes.<br>**C.D.AD.B.12**<br>Analytically locate intervals on which a function is concave up or concave down.<br>**C.D.AD.B.13**<br>Relate corresponding characteristics of the graphs of *f*, *f'*, and *f''*. | **Objectives:**<br>Students will:<br>• Determine intervals on which a function is concave up or concave down.<br>• Find any points of inflection of the graph of a function.<br>• Apply the second derivative test to find relative extrema of a function. | 3.4: Concavity and the Second Derivative Test<br><br>**Additional Resource(s)**<br>Visual Calculus Tutorials<br>Larson Calculus Videos – Section 3.4<br>Calculus Tutorial Videos<br>Khan Academy Calculus Videos | **Writing in Math**<br>*S* represents weekly sales of a product. What can be said of *S'* and *S"* for each of the following statements?<br>✓ The rate of change of sales is increasing.<br>✓ Sales are increasing at a slower rate.<br>✓ The rate of change of sales is constant.<br>✓ Sales are steady.<br>✓ Sales are declining, but at a slower rate.<br>✓ Sales have bottomed out and have started to rise. |

## RESOURCE TOOLKIT

**Textbook Resources**

Larson/Edwards *Calculus of a Single Variable* © 2010

Larson Calculus

**Standards**

Common Core Standards - Mathematics

Common Core Standards - Mathematics Appendix A

Edutoolbox.org (formerly TN Core)

The Mathematics Common Core Toolbox

Tennessee Academic Standards for Mathematics

**Videos**

Larson Calculus Videos

Khan Academy

Hippocampus

Brightstorm

Pre-Calculus Review

**Calculator**

Calculus Activities Using the TI-84

Texas Instruments Education

Casio Education

TI Emulator

Desmos

**Interactive Manipulatives**

http://www.ct4me.net/math_manipulatives_2.htm

Larson Interactive Examples

**ACT & SAT**

TN ACT Information & Resources

ACT College & Career Readiness Mathematics Standards

SAT Connections

SAT Practice from Khan Academy

**Additional Sites**

Visual Calculus Tutorials

Lamar University Tutorial

PowerPoint Lectures

Algebra Cheat Sheet

Trigonometry Cheat Sheet

Online Algebra and Trigonometry Tutorial

Study Tips for Math Courses

MathBits Calculus Resources

Interactive Mathematics Lessons

http://www.freemathhelp.com/calculus-help.html

http://www.calculus.org/

http://www.calcchat.com/

http://functions.wolfram.com

http://www.analyzemath.com/Graphing/piecewise_functions.html