



# Curriculum and Instruction – Mathematics

## Quarter 3

## Precalculus

Quarter 1	Quarter 2		Quarter 3		Quarter 4		
Various Functions & Their Graphs, Polynomials & Polynomial Functions, Inverse Functions	Trigonometric Functions and Their Graphs, Unit Circle, Inverse Trigonometric Functions, Law of Sine, Law of Cosine, Trigonometric Identities		Exponential and Logarithmic Functions, Conic Sections		Systems of Equations and Matrices, Polar Coordinates and Complex Numbers, Sequences and Series, Limits and Introduction to Integrals		
August 12, 2019 – October 11, 2019	October 21, 2019 – December 20, 2019		January 6, 2020 – March 13, 2020		March 23, 2020 – May 22, 2020		
P.F.IF.A.1	P.G.AT.A.1	P.F.GT.A.4	P.A.PE.A.1	P.N.NE.A.3	P.A.REI.A.1	P.N.VM.C.10	P.N.CN.A.1
P.F.IF.A.2	P.G.AT.A.2	P.F.GT.A.5	P.A.PE.A.2	P.N.NE.A.4	P.A.REI.A.2	P.N.VM.C.11	P.N.CN.A.2
P.F.IF.A.4	P.G.AT.A.3	P.F.GT.A.6	P.A.C.A.1	P.N.NE.A.5	P.A.REI.A.3	P.N.VM.C.12	P.N.CN.A.3
P.F.IF.A.6	P.G.AT.A.4	P.F.GT.A.7	P.A.C.A.2		P.A.REI.A.4	P.N.VM.C.13	P.N.CN.A.4
P.F.IF.A.7	P.G.AT.A.5	P.F.GT.A.8	P.A.C.A.3		P.N.VM.A.1	P.G.PC.A.1	P.N.CN.A.5
P.F.BF.A.1	P.G.AT.A.6	P.G.TI.A.1	P.A.C.A.4		P.N.VM.A.2	P.G.PC.A.2	P.N.CN.B.6
P.F.BF.A.3	P.F.TF.A.1	P.G.TI.A.2	P.F.IF.A.2		P.N.VM.A.3	P.G.PC.A.3	P.F.BF.A.4
P.F.BF.A.5	P.F.TF.A.2		P.F.IF.A.5		P.N.VM.B.4	P.A.S.A.1	
P.F.BF.A.6	P.F.TF.A.3		P.S.MD.A.1		P.N.VM.B.5	P.A.S.A.2	
P.N.CN.B.7	P.F.TF.A.4		P.S.MD.A.2		P.N.VM.B.6	P.A.S.A.3	
	P.F.GT.A.1		P.S.MD.A.3		P.N.VM.C.7	P.A.S.A.4	
	P.F.GT.A.2		P.N.NE.A.1		P.N.VM.C.8	P.A.S.A.5	Calculus C.F.LF.A.2
	P.F.GT.A.3		P.N.NE.A.2		P.N.VM.C.9	P.F.IF.A.8	Calculus C.I.UI.A.3



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## 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**.

## Instructional Shifts for Mathematics



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.



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### Topics Addressed in Quarter

- Exponential and Logarithmic Functions
- Conic Sections

### Overview

During quarter three students explore the relationship between exponential functions and their inverses, the logarithmic functions. Building on their work with linear and quadratic functions in Algebra II, students extend their repertoire of functions to include exponential and logarithmic functions. Students work closely with the expressions that define the functions and continue to expand and hone their abilities to use the laws of exponents and logarithms to expand or collect terms in expressions; simplify expressions or modify them in order to analyze them or compare them. Students understand and use the inverse relationship between exponents and logarithms to model situations and solve problems. The quarter concludes with the study of conic sections. Students derive the equations of ellipses and hyperbolas given foci, and from an equation in standard form, students graph the appropriate conic section: ellipses, hyperbolas, circles, and parabolas. Students demonstrate an understanding of the relationship between their standard algebraic form and the graphical characteristics. Given a quadratic equation of the form  $ax^2 + by^2 + cx + dy + e = 0$ , they use the method of completing the square to put the equation in standard form; identify whether the graph of the equation is a circle, parabola, ellipse, or hyperbola as well as graph the equation. Students model situations and solve real-world problems involving conic sections.

TN STATE STANDARDS	CONTENT	INSTRUCTIONAL SUPPORT & RESOURCES	
<b>Exponential and Logarithmic Functions</b> (Allow approximately 6 weeks for instruction, review, and assessment)			
<p><b>Domain:</b> Interpreting Functions</p> <p><b>Cluster:</b> Analyze functions using different representations.</p> <p><b>P.F.IF.A.2</b> Analyze qualities of exponential, polynomial, logarithmic, trigonometric, and rational functions and solve real world problems that can be modeled with these functions (by hand and with appropriate technology). ★</p> <p><b>P.F.IF.A.3</b> Identify or analyze the distinguishing properties of exponential, polynomial, logarithmic, trigonometric, and rational functions from tables, graphs, and equations.</p>	<p><b>Essential Question(s):</b></p> <ul style="list-style-type: none"> <li>• What types of situations can be modeled using exponential growth?</li> <li>• How can we characterize and compare the rates of change in linear function and exponential functions?</li> </ul> <p><b>Objective(s):</b></p> <ul style="list-style-type: none"> <li>• Students will evaluate, analyze, and graph exponential functions.</li> <li>• Students will solve problems involving exponential growth and decay.</li> </ul>	<p><a href="#">engageNY Precalculus and Advanced Topics, Module 3, Topic C- Inverse Functions</a></p> <p><a href="#">Lesson 18: Inverse Functions</a></p> <p><a href="#">Lesson 19: Restricting the Domain</a></p> <p><b>Glencoe</b></p> <p>3-1: Exponential Functions</p> <p><b>Sullivan</b></p> <p>5.3: Exponential Functions</p> <p><b>Task(s):</b></p> <p><a href="#">Spread of Disease</a></p> <p><a href="#">Illustrative Math: Comparing Graphs of</a></p>	<p><b>Vocabulary:</b> algebraic function, transcendental function, exponential function, natural base, continuous compound interest</p> <p><b>Writing in Math/Discussion:</b></p> <p>How can you solve an equation involving logarithmic expressions with three different bases?</p> <p>Research data that can be modeled by an exponential growth equation. Find an equation that models the data. Check your equation by substituting other data points into your equation</p>



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TN STATE STANDARDS	CONTENT	INSTRUCTIONAL SUPPORT & RESOURCES	
		<p><a href="#">Functions</a></p> <p><a href="#">Illustrative Math: Exponential Graphs</a></p> <p><a href="#">GSE Algebra II/Advanced Algebra: Unit 5- Exponential and Logarithmic Functions</a></p> <p><b>Additional Resources:</b></p> <p><a href="#">Khan Academy: Exponential Functions</a></p> <p><a href="#">LearnZillion: Write an Exponential Growth Function</a></p> <p><a href="#">TI Precalculus Activities: Exponential and Logarithmic Functions (TI84)</a></p> <p><a href="#">TI Precalculus Activities: Exponential and Logarithmic Functions (TINspire)</a></p>	
<p><b>Domain:</b> Number Expressions</p> <p><b>Cluster:</b> Represent, interpret, compare, and simplify number expressions.</p> <p><b>P.N.NE.A.1</b> Use the laws of exponents and logarithms to expand or collect terms in expressions; simplify expressions or modify them in order to analyze them or compare them.</p> <p><b>P.N.NE.A.2</b> Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponent.</p> <p><b>Domain:</b> Interpreting Functions</p> <p><b>Cluster:</b> Analyze functions using different representations.</p> <p><b>P.F.IF.A.3</b> Identify or analyze the distinguishing properties of exponential, polynomial, logarithmic, trigonometric, and rational functions from tables, graphs, and</p>	<p><b>Essential Question(s):</b></p> <ul style="list-style-type: none"> <li>Why is it important to analyze functions using different representations?</li> <li>Why is it important to identify and extend the properties of exponents to rational exponents?</li> </ul> <p><b>Objective(s):</b></p> <ul style="list-style-type: none"> <li>Students will evaluate expressions involving logarithms.</li> <li>Students will sketch and analyze graphs of logarithmic functions.</li> <li>Students will evaluate logarithmic expressions with different bases.</li> <li>Students will compare exponential and logarithmic expressions.</li> <li>Students will apply properties of logarithmic functions to solve problems.</li> </ul>	<p><a href="#">engageNY Precalculus and Advanced Topics, Module 3, Topic C- Inverse Functions Lesson 20: Inverses of Logarithmic and Exponential Functions</a></p> <p><a href="#">Lesson 21: Logarithmic and Exponential Problem Solving</a></p> <p><b>Glencoe</b></p> <p>3-2: Logarithmic Functions</p> <p>3-3 Properties of Logarithms</p> <p>3-4 Exponential and Logarithmic Equations</p> <p><b>Sullivan</b></p> <p>5.4: Logarithmic Functions</p> <p>5-5 Properties of Logarithms</p> <p>5-6 Logarithmic and Exponential Equations</p> <p><b>Task(s):</b></p> <p><a href="#">Illustrative Math: Properties of Exponents</a></p> <p><a href="#">Illustrative Math: Exponential Expressions</a></p>	<p><b>Vocabulary:</b> logarithm, common logarithm, base, logarithmic function, natural logarithm</p> <p><b>Writing in Math/Discussion:</b></p> <p>Use words, graphs, tables and equations to compare logarithmic and exponential functions.</p>



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TN STATE STANDARDS	CONTENT	INSTRUCTIONAL SUPPORT & RESOURCES	
equations.	<ul style="list-style-type: none"> <li>Students will solve exponential and logarithmic equations and inequalities.</li> </ul>	<a href="#">GSE Algebra II/Advanced Algebra: Unit 5- Exponential and Logarithmic Functions</a>  <b>Additional Resources:</b> <a href="#">Khan Academy Functions: Linear, Quadratic, and Exponential Models</a>	
<p><b>Domain:</b> Model with Data ★</p> <p><b>Cluster:</b> Model data using regression equations</p> <p><b>P.S. MD.A.1</b> Create scatter plots, analyze patterns and describe relationships for bivariate data (linear, polynomial, trigonometric or exponential) to model real-world phenomena and to make predictions.</p> <p><b>P.S. MD.A.2</b> Determine a regression equation to model a set of bivariate data. Justify why this equation best fits the data.</p> <p><b>P.S. MD.A.3</b> Use a regression equation modeling bivariate data to make predictions. Identify possible considerations regarding the accuracy of predictions when interpolating or extrapolating.</p>	<p><b>Essential Question(s):</b></p> <ul style="list-style-type: none"> <li>How would you analyze bivariate data using your knowledge of proportions?</li> <li>How would you use your knowledge of functions to fit models to quantitative data?</li> </ul> <p><b>Objective(s):</b></p> <ul style="list-style-type: none"> <li>Model data using exponential and logarithmic functions and analyze this data.</li> <li>Conduct simple experiments or investigations to collect linear and non-linear data to answer questions of interest.</li> <li>Make inferences or predictions using an algebraic model of experiments or investigations.</li> </ul>	<p><b>Glencoe</b></p> <p>3-5: Modeling with Nonlinear Regression</p> <p><b>Sullivan</b></p> <p>5.7: Financial Models</p> <p>5.8: Exponential Growth and Decay Models; Newton's Law; Logistic Growth and Decay Models</p> <p><b>Additional Lessons:</b></p> <p><a href="#">Better Lesson: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related</a></p> <p><b>Tasks:</b></p> <p><a href="#">Illustrative Math: Summarize, represent, and interpret data on two categorical and quantitative variables</a></p> <p><b>Additional Resources</b></p> <p><a href="#">NCTM Illuminations: Line of Best Fit</a></p> <p><a href="#">NCTM Illuminations: Linear Regression Interactive</a></p> <p><a href="#">Fitting Functions to Models</a></p>	<p><b>Vocabulary:</b> logistic growth function, linearized, interpolate, extrapolate</p> <p><b>Writing in Math/Discussion:</b></p> <p>Explain how the parameters of an exponential or logarithmic model relate to the data set or situation being modeled.</p>
<p><b>Conic Sections</b>  <b>(Allow approximately 2 weeks for instruction, review and assessment)</b></p>			
<p><b>Domain:</b> Interpreting Functions</p> <p><b>Cluster:</b> Analyze functions using different representations.</p>		<p><a href="#">engageny Algebra II, Module 1, Topic C- Lesson 33: The Definition of a Parabola</a></p> <p><a href="#">Lesson 34: Are All Parabolas Congruent?</a></p>	<p><b>Vocabulary:</b> conic sections, degenerate conics, locus, parabola, focus, directrix, axis of symmetry, vertex, major axis, ellipse, foci,</p>



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<p><b>P.F.IF.A.5</b> Identify characteristics of graphs based on a set of conditions or on a general equation such as <math>y = ax^2 + c</math>.</p> <p><b>Domain:</b> Conic Sections</p> <p><b>Cluster:</b> Understand the properties of conic sections and apply them to model real-world phenomena.</p> <p><b>P.A.C.A.2</b> Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.</p> <p><b>P.A.C.A.3</b> From an equation in standard form, graph the appropriate conic section: ellipses, hyperbolas, circles, and parabolas. Demonstrate an understanding of the relationship between their standard algebraic form and the graphical characteristics.</p>	<p><b>Essential Question(s):</b></p> <ul style="list-style-type: none"> <li>How would you relate and interpret features of relationships represented in a graph, table, and verbal descriptions?</li> <li>What role do foci play in the definition of conic quadratic relations?</li> <li>How can conic sections be identified by the <math>A</math> and <math>C</math> coefficients from the general form of quadratic relations?</li> </ul> <p><b>Objective(s):</b></p> <ul style="list-style-type: none"> <li>Students will analyze and graph equations of parabolas.</li> <li>Students will write equations of parabolas.</li> <li>Students will analyze and graph equations of ellipses and circles.</li> <li>Students will analyze and graph equations of hyperbolas.</li> </ul>	<p><a href="#">Lesson 35: Are All Parabolas Similar?</a></p> <p><b>Glencoe</b></p> <p>7-1: Parabolas 7-2: Ellipses and Circles 7-3: Hyperbolas 7-4 Extend: Systems of Nonlinear Equations and Inequalities</p> <p><b>Sullivan</b></p> <p>10.2: The Parabola 10.3: The Ellipse 10.4: The Hyperbola</p> <p><b>Additional Lessons:</b></p> <p><a href="#">Better Lesson: Skyscraper Problem and Explore the Rebound Height of a Ball</a> <a href="#">Online Learning Video: Equations of Ellipses and Hyperbolas</a> <a href="#">Khan Academy: Expressing Geometric Properties with Equations</a> <a href="#">Better Lesson: The Ellipse Days 1, 2 &amp; 3</a></p> <p><b>Tasks:</b></p> <p><a href="#">Inside Mathematics: Sorting Functions</a> <a href="#">GSE Precalculus: Unit 6 -Conics</a></p> <p><b>Additional Resources:</b></p> <p><a href="#">Purple Math: Conics</a> <a href="#">Hot Math: Conic Sections and Their Equations</a> <a href="#">Illustrations: Conics Section Interactive</a> <a href="#">Illustrations: Cutting Conics</a></p>	<p>center, minor axis, co-vertex, eccentricity, hyperbola, transverse axis, conjugate axis</p> <p><b>Writing in Math/Discussion:</b></p> <ul style="list-style-type: none"> <li>Explain why an ellipse becomes circular as the value of <math>a</math> approaches the value of <math>c</math>.</li> <li>Explain how you can determine the concavity of a parabola given its focus and vertex.</li> </ul>





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TN STATE STANDARDS	CONTENT	INSTRUCTIONAL SUPPORT & RESOURCES	
<b>Parametric Equations</b> (Allow approximately 1 week for instruction, review and assessment)			
<p><b>Domain:</b> Parametric Equations  <b>Cluster:</b> Describe and use parametric equations. ★  <b>P.A.PE.A.1</b> Graph curves parametrically (by hand and with appropriate technology).  <b>P.A.PE.A.2</b> Eliminate parameters by rewriting parametric equations as a single equation.</p>	<p><b>Essential Question(s):</b></p> <ul style="list-style-type: none"> <li>Why is it important to define functions and equations parametrically?</li> </ul> <p><b>Objective(s):</b></p> <ul style="list-style-type: none"> <li>Students will graph parametric equations.</li> <li>Students will solve systems of nonlinear inequalities by graphing.</li> </ul>	<p><b>Glencoe</b>            7-5: Parametric Equations  <b>Sullivan</b>            10.7: <i>Plane Curves and Parametric Equations</i>            11.6: <i>Systems of Nonlinear Equations</i>            11.7: <i>Systems of Inequalities</i>  <b>Additional Lessons:</b>  <a href="#">Khan Academy: Intro to Parametric Equations</a>  <a href="#">NCTM Illuminations Lesson: Mars Orbit</a></p>	<p><b>Vocabulary:</b> parametric equation, parameter, orientation, parametric curve</p> <p><b>Writing in Math/Discussion:</b>            Explain the advantage of using parametric equations versus rectangular equations when analyzing the horizontal/vertical components of a graph.</p>

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### RESOURCE TOOLKIT

<p><b>Textbook Resources</b>  <b>Glencoe Precalculus © 2011</b>  <a href="http://connected.mcgraw-hill.com/connected/login.do">http://connected.mcgraw-hill.com/connected/login.do</a></p> <p><b>Sullivan Precalculus: Enhanced with Graphing Utilities, 5e © 2009.</b></p>	<p><b>Standards</b>  <a href="#">Common Core Standards - Mathematics</a>  <a href="#">Common Core Standards - Mathematics Appendix A</a>  <a href="#">The Mathematics Common Core Toolbox</a>  <a href="#">Common Core Lessons</a>  <a href="#">Tennessee Academic Standards for Mathematics</a></p>	<p><b>Videos</b>  <a href="#">Khan Academy</a>  <a href="#">Lamar University Tutorial</a>  <a href="#">UCI Precalculus Instructional Videos</a>  <a href="#">Flipped Math - Precalculus</a></p>
<p><b>Calculator</b>  <a href="#">Texas Instruments Education</a>  <a href="#">Texas Instruments - Precalculus Activities</a>  <a href="#">Casio Education</a>  <a href="#">TI Emulator</a>  <a href="#">Math Nspired</a>  <a href="#">Desmos</a></p>	<p><b>Interactive Manipulatives</b>  <a href="http://www.ct4me.net/math_manipulatives_2.htm">http://www.ct4me.net/math_manipulatives_2.htm</a>  <a href="#">Illuminations (NCTM)</a></p> <p><b>ACT &amp; SAT</b>  <a href="#">TN ACT Information &amp; Resources</a>  <a href="#">ACT College &amp; Career Readiness Mathematics Standards</a>  <a href="#">ACT Academy</a>  <a href="#">SAT Connections</a>  <a href="#">SAT Practice from Khan Academy</a></p> <p><b>Tasks/Lessons</b>  <a href="#">UT Dana Center</a>  <a href="#">Inside Math Tasks</a>  <a href="#">Math Vision Project Tasks</a>  <a href="#">Better Lesson</a>  <a href="#">Edutoolbox</a>  <a href="#">GSE Precalculus: Unit 1 Introduction to Trigonometric Functions</a>  <a href="#">GSE Precalculus: Unit 2 Trigonometric Functions</a>  <a href="#">GSE Precalculus: Unit 4 Trigonometric Identities</a></p>	<p><b>Additional Sites</b>  <a href="http://functions.wolfram.com">http://functions.wolfram.com</a>  <a href="http://www.analyzemath.com/Graphing/piecewise_functions.html">http://www.analyzemath.com/Graphing/piecewise_functions.html</a>  <a href="http://www.purplemath.com/">http://www.purplemath.com/</a>  <a href="http://www.onlinemathlearning.com/math-word-problems.html">http://www.onlinemathlearning.com/math-word-problems.html</a>  <a href="http://education.ti.com/calculators/downloads/US/Activities/Detail?id=9530">http://education.ti.com/calculators/downloads/US/Activities/Detail?id=9530</a>  <a href="#">Better Lesson</a>  <a href="#">Algebra Cheat Sheet</a>  <a href="#">Trigonometry Cheat Sheet</a>  <a href="#">Online Algebra and Trigonometry Tutorial</a>  <a href="#">Study Tips for Math Courses</a></p>