

Ledyard Public Schools PreCalculus Curriculum



Course Description

Building on foundational concepts and skills presented in the geometry and algebra 2 curricula, this course curriculum begins with solving and graphing polynomial, rational, and exponential and logarithmic functions. The second portion of the course is devoted to topics in trigonometry. Topics include right triangle trigonometry, oblique triangles, the law of sines and cosines, graphing trigonometric functions, and solving related equations. Other topics, such as conics and sequences & series, may be included as time allows.

Real-life applications and problem-solving skills are integrated throughout the course.

Topic pacing and instructional depth may be adjusted to accommodate the learning needs of level 1 and level 2 students.

UNIT 1: Polynomial and Rational Functions		Pacing: 8 Blocks
Description	Students extend their prior knowledge to learn about polynomial and rational functions. By examining their properties, students will analyze the features of the graphs.	
Essential Questions	<ol style="list-style-type: none"> How can we use prior knowledge of polynomial functions to connect to rational functions? What features can be determined about a function from its equation? 	
Learning Targets	<p><u>Topic 1- Graphical Behavior of Polynomial Functions</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Identify the degree of the polynomial from both standard and factored form <input type="checkbox"/> Identify the real zeros and their multiplicities of a polynomial from factored form <input type="checkbox"/> Analyze the graph of a polynomial function: end behavior, y-intercept, x-intercept(s) with a touch versus cross behavior <input type="checkbox"/> Express the end behavior of a polynomial function using arrow or limit notation <input type="checkbox"/> Determine the intervals on which the polynomials function has positive or negative value <input type="checkbox"/> Sketch the graph of a polynomial function and label its key features <input type="checkbox"/> Construct the equation of a polynomial function in factored form given its zeros and end behavior <p><u>Topic 2- Zeros of Polynomial Functions</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Use Remainder and Factor Theorems determine whether a given value of x is a zero of a polynomial function in standard form <input type="checkbox"/> Identify the candidates of the rational zeros of a polynomial function given in standard form by applying the Rational Zero Theorem <input type="checkbox"/> Use synthetic division to depress a polynomial and/or find all zeros (real and complex) <input type="checkbox"/> Write a polynomial function as a product of its linear factors over the reals <input type="checkbox"/> Recognize irrational and complex zeros occur as conjugate pairs <input type="checkbox"/> Construct the equation of a polynomial function given specified zeros with multiplicities <input type="checkbox"/> Solve a polynomial function over all complex zeros <p><u>Topic 3- Rational Functions</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Find the domain of a rational function <input type="checkbox"/> Find the discontinuities (ie. hole(s), vertical asymptote(s)) and x-intercept(s) of the graph of a rational function using factoring <input type="checkbox"/> Determine whether the graph of a rational function has a horizontal or non-horizontal asymptote defining its end behavior using the Leading Coefficients Test <input type="checkbox"/> Express the end behavior of a rational function using arrow or limit notation <input type="checkbox"/> Sketch the graph of the rational function and label key features <input type="checkbox"/> Given the graph, write the rational function <p><u>Extensions</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Find upper and lower bounds on zeros <input type="checkbox"/> Use Descartes' Rule of Signs to determine the possible numbers of positive or negative zeros 	
Vocabulary	Unit Word Bank	
Suggested Learning Activities	SAT Released Practice Questions from College Board	

	Desmos Activities- Polynomial Graphing: Behavior at the x-intercepts Desmos Activity- Constructing Polynomials Desmos Activity- Rational Functions 1 Desmos Activity- Rational Functions 2	
Technology Enhancements	<u>TI-84 Features to be Embedded</u> and <u>Desmos</u> https://www.desmos.com/ Utilize the Window, Graph, and Table features to investigate/verify the graphs of Polynomial and Rational Functions	
Assessments	Students will complete: <ul style="list-style-type: none"> <input type="checkbox"/> Ongoing check-ins (Collected warm ups, exit tickets, etc) <input type="checkbox"/> Quizzes & summative Unit Assessment 	
Alignments	Textbook	Chapter 4: Sections 1, 2, 3, 5, 6
	CCS	A-APR.2 , A-APR.3 , A-APR.6 , F-IF.4 , F-IF.7

UNIT 2: Exponential and Logarithmic Functions

Pacing:
10 Blocks

Description	Students extend their prior knowledge to learn about exponential and logarithmic functions. These functions are widely applied across many fields such as Science and Economics.
Essential Questions	<ol style="list-style-type: none"> 1. How is an inverse relationship used to connect exponential and logarithmic functions? 2. What features can be determined about a function from its equation? 3. How are the solutions of exponential and logarithmic functions connected to real world problems?
Learning Targets	<p>Topic 1 - Exponential Functions and their Graphs</p> <ul style="list-style-type: none"> <input type="checkbox"/> Evaluate exponential expressions and functions <input type="checkbox"/> Sketch the graph of exponential functions (both growth and decay) using prior knowledge of transformations <input type="checkbox"/> Rewrite exponential expressions and functions using properties of exponents <input type="checkbox"/> Solve exponential equations with common bases <input type="checkbox"/> Define the number e and apply as a base with exponential functions <input type="checkbox"/> Solve real world problems (compound interest, exponential growth) using exponential functions <p>Topic 2 - Logarithmic Functions and their Graphs</p> <ul style="list-style-type: none"> <input type="checkbox"/> Recognize logarithmic function as the inverse of exponential functions both algebraically as compositions of one another and graphically as reflections over the line $y = x$ <input type="checkbox"/> Apply the definition of a logarithmic function to be able to transpose between logarithmic and exponential forms <input type="checkbox"/> Algebraically, find the inverse function of a given exponential or logarithmic function <input type="checkbox"/> Determine the domain of a logarithmic function <input type="checkbox"/> Graph logarithmic functions using prior knowledge of transformations <input type="checkbox"/> Solve logarithmic equations in the form of $\log = \log$ (common bases) or $\log = \text{real number}$ <p>Topic 3 - Exponential and Logarithmic Expressions and Equations</p> <ul style="list-style-type: none"> <input type="checkbox"/> Solve an exponential or logarithmic equation by transposing between logarithmic and exponential forms <input type="checkbox"/> Solve real-world problems modeled by an exponential function by transposing into logarithmic and form <input type="checkbox"/> Evaluate or simplify logarithmic expressions using the properties of logarithms as derived from exponent properties
Vocabulary	Unit Word Bank
Suggested Learning Activities	<p>Logarithm Puzzle - 16 square pieces with solutions and equations on each side. Solve equations & match to solutions to create a rectangular puzzle. Logarithm Puzzle</p> <p>Research the McDonald's Hot Coffee lawsuit and/or Dunkin Donuts Hot Cider lawsuit when studying Newton's Law of Cooling. McDonald's Lawsuit Dunkin Donuts Lawsuit</p> <p>SAT Released Practice Questions from College Board</p>
Technology Enhancements	<p>TI-84 Features to be Embedded and Desmos https://www.desmos.com/</p> <p>Use calculator shortcut Math-Alpha-Math to evaluate logarithms with different bases</p>
Assessments	Students will complete:

	<input type="checkbox"/> Ongoing check-ins (Collected warm ups, exit tickets, etc) <input type="checkbox"/> Quizzes & summative Unit Assessment	
Alignments	Textbook	Chapter 5: Sections 1 - 8
	CCS	A-SSE.3 , A-CED.1 , A-REI.11 , F-IF.4 , F-IF.7 , F-IF.8 , F-BF.4 , F-BF.5 , F-LE.2 , F-LE.4 , F-LE.5

UNIT 3: Trigonometric Functions

Pacing:
12 Blocks

Description	Students expand their knowledge of right triangle trigonometry to include the three reciprocal trigonometric functions with features of the unit circle. Students conclude the unit by studying the graphs of the six trigonometric functions.
Essential Questions	<ol style="list-style-type: none"> 1. How does right triangle trigonometry relate to trigonometry in a unit circle? 2. What features can be determined about a function from its equation? 3. How do trigonometric functions relate to real world applications?
Learning Targets	<p><u>Topic 1 - Intro to the Unit Circle</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Knowledge of the Unit Circle: \pm degrees, radians and coordinates <p><u>Topic 2 - Radian Measure</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Convert: degrees \Leftrightarrow radians <input type="checkbox"/> Calculate arc length <input type="checkbox"/> Calculate area of sector <input type="checkbox"/> Evaluate linear speed of an object traveling in circular motion <p><u>Topic 3 - Right Triangle Trig on the unit circle</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Knowledge of the six trigonometric functions <input type="checkbox"/> Find exact values of the six trigonometric functions given an ordered pair <input type="checkbox"/> Find exact values of the six trigonometric functions given on quadrantal angles <input type="checkbox"/> Find exact values of the six trigonometric functions of $\frac{\pi}{4}$, $\frac{\pi}{6}$, $\frac{\pi}{3}$, and their integer multiples <p><u>Topic 4 - Trigonometric Identities & Even/Odd properties</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Knowledge of domain and range of the six trigonometric functions <input type="checkbox"/> Determine the period of a trigonometric function <input type="checkbox"/> Given the quadrant, conclude the signs of the six trigonometric functions <input type="checkbox"/> Evaluate trigonometric functions using fundamental identities <input type="checkbox"/> Evaluate trigonometric functions using even/odd properties <p><u>Topic 5 - Graph Sine & Cosine Functions</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Graph the parent functions for $f(x) = \sin x$ and $f(x) = \cos x$ <input type="checkbox"/> Identify the features of the above parent functions: domain, range, intercepts, etc. <input type="checkbox"/> Using transformations, determine the features of $f(x) = a \sin(bx + c) + d$ and $f(x) = a \cos(bx + c) + d$ <input type="checkbox"/> Graph sinusoidal functions using key points <input type="checkbox"/> Given the graph create the sinusoidal function <p><u>Topic 6 - Graph Tangent & trig reciprocal functions</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Graph the parent functions for $f(x) = \tan x$, $f(x) = \csc x$, $f(x) = \sec x$ and $f(x) = \cot x$ <input type="checkbox"/> Identify the features of the above parent functions: domain, range, intercepts, etc. <input type="checkbox"/> Using transformations, determine the features of $f(x) = a \tan(bx + c) + d$, $f(x) = a \csc(bx + c) + d$, $f(x) = a \sec(bx + c) + d$ and $f(x) = a \cot(bx + c) + d$
Vocabulary	Unit Word Bank

Suggested Learning Activities	Unit Circle Trainer - blank template for special angle practice Unit Circle Trainer Geogebra - special angles on the unit circle (graphs & evaluation) Geogebra	
Technology Enhancements	TI-84 Features to be Embedded and Desmos https://www.desmos.com/ Utilize the Window, Graph, and Table features to investigate/verify graphs of Trigonometric Functions	
Assessments	Students will complete: <input type="checkbox"/> Ongoing check-ins (Collected warm ups, exit tickets, etc) <input type="checkbox"/> Quizzes & summative Unit Assessment	
Alignments	Textbook	Chapter 6: Sections 1-6
	CCS	F-C.5 , F-TF.1 , F-TF.2 , F-TF.3 , F-TF.4 , F-TF.5

UNIT 4: Analytic Trigonometry - Level 1 only		Pacing: 9 Blocks
Description	Students expand their knowledge of trigonometric functions to prove identities and solve equations.	
Essential Questions	<ol style="list-style-type: none"> How can you use deductive reasoning skills to prove and confirm established trigonometric identities? How can you use your knowledge of linear and quadratic functions to solve trigonometric functions? 	
Learning Targets	<p>Topic 1 - Inverse Trig Functions (sin,cos,tan)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Find exact value of inverse sine, cosine, tangent and composite functions <input type="checkbox"/> Solve equations involving inverse trigonometric functions <input type="checkbox"/> Write a trigonometric expression as an algebraic expression <p>Topic 2 - Trig Identities & Expressions</p> <ul style="list-style-type: none"> <input type="checkbox"/> Establish identities such as: quotient, reciprocal, Pythagorean <input type="checkbox"/> Use Algebra to simplify trigonometric expressions <p>Topic 3 - Sum & Difference Formulas</p> <ul style="list-style-type: none"> <input type="checkbox"/> Use sum and difference formulas to find exact values <p>Topic 4 - Double-angle & Half-angle Formulas</p> <ul style="list-style-type: none"> <input type="checkbox"/> Use double-angle and half-angle formulas to find exact values <p>Topic 5 - Solve Trig Equations (linear/quadratic)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Solve equations involving linear and quadratic trigonometric functions 	
Vocabulary	Unit Word Bank	
Suggested Learning Activities	Cut & Paste activity to practice proving trig identities Cut & Paste Activity	
Technology Enhancements	TI-84 Features to be Embedded and Desmos https://www.desmos.com/	
Assessments	<p>Students will complete:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ongoing check-ins (Collected warm ups, exit tickets, etc) <input type="checkbox"/> Quizzes & summative Unit Assessment 	
Alignments	Textbook	Chapter 7: Sections 1-5, 7, 8
	CCS	F-TF.6 , F-TF.7 , F-TF.8 , F-TF.9

UNIT 5: Applications of Trigonometric Functions

Pacing:
7 Blocks

Description	Students expand their knowledge of right triangle trigonometry to solve applied problems. Students develop the Laws of Sines and Cosines to solve non-right triangles.	
Essential Questions	<ol style="list-style-type: none"> How can trigonometry be used to solve real world applications? Why is it important to understand right triangle trigonometry for the study of trigonometry in oblique triangles? 	
Learning Targets	<p>Topic 1 - Review Right Triangles & Trigonometric Ratios</p> <ul style="list-style-type: none"> Using right triangles, find the ratios of the six trigonometric functions. Solve right triangles: find all angles and side lengths Solve applied problems using right triangles <p>Topic 2 - Law of Sines</p> <ul style="list-style-type: none"> Use Law of Sines to solve triangles given Angle-Angle-Side or Angle-Side-Angle information Use Law of Sines to solve triangles in the ambiguous case (Side-Side-Angle) Solve applied problems using Law of Sines <p>Topic 3 - Law of Cosines</p> <ul style="list-style-type: none"> Use Law of Cosines to solve triangles given Side-Angle-Side or Side-Side-Side information Solve applied problems using Law of Cosines <p>Topic 4 - Area of Oblique Triangles (SAS/SSS)</p> <ul style="list-style-type: none"> Find the area of a triangle given Side-Angle-Side or Side-Side-Side information Solve applied problems using the area of a triangle <p><i>Level 1 Extension</i></p> <p>Topic 5 - Polar Coordinates</p> <ul style="list-style-type: none"> Plot points using Polar Coordinates Convert Polar Coordinates \Leftrightarrow Rectangular Coordinates 	
Vocabulary	Unit Word Bank	
Suggested Learning Activities	<p>Law of Sines and Cosines - Desmos Activity Desmos (instructional video included)</p> <p>The Engineering Toolbox - practice law of sines/cosines, and area formulas Engineering Toolbox</p>	
Technology Enhancements	<p>TI-84 Features to be Embedded and Desmos https://www.desmos.com/</p>	
Assessments	<p>Students will complete:</p> <ul style="list-style-type: none"> Ongoing check-ins (Collected warm ups, exit tickets, etc) Quizzes & summative Unit Assessment 	
Alignments	Textbook	<p>Chapter 8: Sections 1-4</p> <p>Chapter 9: Section 1</p>
	CCS	G-SRT.6 , G-SRT.7 , G-SRT.8 , G-SRT.9 , G-SRT.10 , G-SRT.11

UNIT 6: Conics

Pacing:
9 Blocks

Description	Students expand their knowledge of the distance formula and rectangular coordinates to obtain equations for conic sections. Students use the properties of equations in standard form to identify and graph the conic sections.
Essential Questions	<ol style="list-style-type: none"> How does the distance formula and rectangular coordinates connect to the equations of the conic sections? How can conics be used to solve real world applications?
Learning Targets	<p>Topic 1 - Cross Sections</p> <ul style="list-style-type: none"> Understand the cross-section views of a cone to generate the conics: circle, parabola, ellipse and hyperbola <p>Topic 2 - Circles</p> <ul style="list-style-type: none"> Write the equation of a circle in standard form: $(x - h)^2 + (y - k)^2 = r^2$ Graph a circle by hand and with a graphing device (TI-84 or Desmos) Transform from general form to standard form of a circle by completing the square <p>Topic 3 - Parabolas</p> <ul style="list-style-type: none"> Recognize the transformation function of a parabola: $y = a(x - h)^2 + k$ and $x = a(y - k)^2 + h$ Identify features of the parabola: vertex, focus, directrix, x and y-intercept(s) Describes the transformations of the parabola in comparison to its parent function: $y = x^2$ or $x = y^2$ Solve applied problems involving parabolas <p>Topic 4 - Ellipses</p> <ul style="list-style-type: none"> Recognize the transformation function of an ellipse: $\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$ Identify features of the ellipse: center, foci, major and minor axes, x and y-intercept(s) Describes the transformations of the ellipse in comparison to its parent function $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ Solve applied problems involving ellipses <p>Topic 5 - Hyperbolas</p> <ul style="list-style-type: none"> Recognize the transformation function of a hyperbola: $\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$ or $\frac{(y-k)^2}{b^2} - \frac{(x-h)^2}{a^2} = 1$ Identify features of the hyperbola: center, vertices, foci, oblique asymptotes: $y = \pm \frac{b}{a}x$ or $y = \pm \frac{a}{b}x$, x and y-intercept(s) Describes the transformations of the hyperbola in comparison to its parent function $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ or $\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$ Solve applied problems involving hyperbola
Vocabulary	Unit Word Bank

Suggested Learning Activities	Conics by Desmos - 7 activities Conic Flyer with PDF worksheet	
Technology Enhancements	TI-84 Features to be Embedded and Desmos https://www.desmos.com/	
Assessments	Students will complete: <ul style="list-style-type: none"> <input type="checkbox"/> Ongoing check-ins (Collected warm ups, exit tickets, etc) <input type="checkbox"/> Quizzes & summative Unit Assessment 	
Alignments	Textbook	Chapter 10: Sections 1-4 Chapter 1: Section 5
	CCS	G-GPE.1 , G-GPE.2 , G-GPE.3 , G-GPE.4

UNIT 7: Sequences & Series **Level 1 only**

Pacing:
7 Blocks

Description	Sequences and Series + if time permits	
Essential Questions	<ol style="list-style-type: none"> 1. What are sequences and series and how are they related? 2. What is an arithmetic sequence/series? What is a geometric sequence/series? 3. How can you represent an arithmetic/geometric sequence as a formula or with summation notation? 4. How can you determine whether a geometric series converges or diverges? 5. How can we use sequences and series as models for given real life situations? 	
Learning Targets	<p>Topic 1 - Sequence Sums</p> <ul style="list-style-type: none"> <input type="checkbox"/> Investigate and confirm the formulas for sums of sequences <input type="checkbox"/> Apply the summation notation to sequences <input type="checkbox"/> Use the summation formulas to calculate the sum of the sequence <input type="checkbox"/> Analyze Financial Applications as a derivative of summation formulas <p>Topic 2 - Arithmetic Sequences</p> <ul style="list-style-type: none"> <input type="checkbox"/> Define and recognize an Arithmetic Sequence <input type="checkbox"/> Derive the formula for an Arithmetic Sequence <input type="checkbox"/> Use the formula for an Arithmetic Sequence to solve an unknown <input type="checkbox"/> Find the sum of an Arithmetic Sequence as supported by the summation formulas <p>Topic 3 - Geometric Sequences</p> <ul style="list-style-type: none"> <input type="checkbox"/> Define and recognize a Geometric Sequence <input type="checkbox"/> Derive the formula for a Geometric Sequence <input type="checkbox"/> Use the formula for a Geometric Sequence to solve an unknown <input type="checkbox"/> Find the sum of a Geometric Sequence as supported by the summation formulas <input type="checkbox"/> Determine if a Geometric Series converges or diverges 	
Vocabulary	Unit Word Bank	
Suggested Learning Activities	Quizziz - Sequences and Series Practice Sequences warm ups & activities Transum website	
Technology Enhancements	TI-84 Features to be Embedded and Desmos https://www.desmos.com/	
Assessments	Students will complete: <ul style="list-style-type: none"> <input type="checkbox"/> Ongoing check-ins (Collected warm ups, exit tickets, etc) <input type="checkbox"/> Quizzes & summative Unit Assessment 	
Alignments	Textbook	Chapter 12: Sections 1-3
	CCS	F-BF.1 , F-BF.2

UNIT 8: Introduction to Limits **Level 1 only**

Pacing:
7 Blocks

Description	Intro to Limits + if time permits	
Essential Questions	<ol style="list-style-type: none"> 1. How do limits describe the behavior of a function? 2. What are the strategies used to determine the limit of a function? 3. What determines continuity and how can you find and describe discontinuities? 	
Learning Targets	<p><u>Topic 1 - Limits (numerical)</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Find a limit using a table and a graph <p><u>Topic 2 - Limits (algebraic)</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Find the limit of a polynomial and a quotient <input type="checkbox"/> Find the limit of an average rate of change <p><u>Topic 3 - Continuity & One-sided limits</u></p> <ul style="list-style-type: none"> <input type="checkbox"/> Find the one-sided limit of a function <input type="checkbox"/> Determine whether a function is continuous 	
Vocabulary	Unit Word Bank	
Suggested Learning Activities	Desmos - Limits & Continuity	
Technology Enhancements	TI-84 Features to be Embedded and Desmos https://www.desmos.com/	
Assessments	<p>Students will complete:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ongoing check-ins (Collected warm ups, exit tickets, etc) <input type="checkbox"/> Quizzes & summative Unit Assessment 	
Alignments	Textbook	Chapter 14: Sections 1-3
	CCS	n/a