PRECALCULUS CURRICULUM GUIDE

Overview and Scope & Sequence

Loudoun County Public Schools
2017-2018

(Additional curriculum information and resources for teachers can be accessed through CMS and VISION)

Pre-calculus Semester Overview

The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations as they engage in mathematics activities throughout the year.

1st Semester	2nd Semester
Unit 1 – Matrices AA.1 AA.2 MA.14 **Unit 2 – Conic Sections** AA.3 AA.4 MA.8 **Unit 3 – Introduction to Trigonometry, Unit Circle, Graphing Trigonometric Functions, Inverse Trigonometric Functions (Continued in Semester 2)** AA.5 AA.6 AA.7 AA.8 AA.9 AA.10 AA.11 AA.12 T.3 T.1 T.2 T.4 T.6 T.7	**Unit 4 – Trigonometric Identities, Equations and Applications (Continued from Semester 1)** AA.11 AA.13 T.5 T.8 MA.13 (T. 9) **Unit 5 – Polynomial and Rational Functions Review** AII.6 MA.1 **Unit 6 – Exponential and Logarithmic Functions** AA.14 MA.9 **Unit 7 – Sequences and Series** AA.15 AA.16 AA.17 MA.5 MA.4 **Unit 8 – Topics from Calculus: Limits (if time allows)** MA.7
46 blocks	**43 blocks**

Pre-Calculus Scope and Sequence

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources

Unit 1
 	
3-4
	Matrices
	  Writing a matrix
	   • Dimensions
	
	Operations
	  • Addition
	  • Subtraction
	  • Scalar Multiplication
	
	Matrix Multiplication
	  • Larger than a 2 X 2 on calculator only, all others without the aid of a calculator
	
	Determinants
	  • Larger than a 2 X 2 on calculator only, all others without the aid of a calculator
	  • Meaning of a determinant of zero
	
	Solving systems of equations
	  • Write the system as a matrix
	  • Solve using an inverse matrix
	  • Larger than a 2 X 2 on calculator only, but write the matrix equation
	
	Applications involving matrices
	  • Area of a triangle
	  • Determine if points are collinear
	  • Cryptography
	  • Equation of Parabola given 3 points
		MA.14 The student will use matrices to organize data and will add and subtract matrices, multiply matrices, multiply matrices by a scalar, and use matrices to solve systems of equations.	**Websites –**
			
			www.kutasoftware.com for free worksheets
			
			www.edhelper.com for free worksheets
			
			www.math.about.com for free worksheets
			
			Applications of Matrices and Determinants
			
			Precalculus: All Systems Go! by Texas Instruments
			
			Algebra II: Solving Systems Using Matrices by Texas Instruments
			
			Problem Set – Quarter 1
			Problem Set – Quarter 2

	1 block – **Suggested assessment, enrichment, and remediation for this unit.**		

Number of Blocks	Topic and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
Unit 2 **7-8**	**Conic Sections** **Circle** • Graph a circle given standard or general form • Write the equation of a circle given information about its center, radius, or diameter • Convert between Standard Form and General Form • Recognize the equation of a semi-circle centered at the origin **Ellipse** • Define an ellipse using the foci • Identify whether the ellipse is horizontal or vertical • Graph the ellipse – identify the major/minor axes, the center, the vertices, and the foci • Write the equation of the ellipse given the center, foci, vertices, or axes • Convert between Standard Form and General Form **Hyperbola** • Define a hyperbola using the foci • Identify whether the hyperbola is horizontal or vertical • Graph the hyperbola –identify the center, vertices, foci and the equations of the asymptotes • Write the equation of the hyperbola given information about the center, vertices, foci or the equations of the asymptotes • Convert between Standard Form and General Form	**MA.8** The student will investigate and identify the characteristics of conic section equations in (h, k) and standard forms. Transformations in the coordinate plane will be used to graph conic sections.	**Websites –** http://math2.org/math/algebra/conics.htm to see pictures of how the conic sections are formed when a plane cuts through a cone. This website will also have the equations for the conic sections. To see some awesome pictures of conics and to read about the history of conics, visit http://xahlee.org/SpecialPlaneCurves_dir/ConicSections_dir/conicSections.html Visit this website for further lessons on how to work conic section problems. There are also some real-life applications to be found here. http://jwilson.coe.uga.edu/emt669/student.Folders/Jones.June/conics/conics.html

Number of Blocks	Topic and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
	Parabola • Define a parabola using the focus and the directrix • Identify whether the parabola is horizontal or vertical and how it opens • Graph a parabola – identify the vertex, focus, directrix and latus rectum • Write the equation of a graph given the vertex, focus, directrix or latus rectum • Convert between Standard Form and General Form		**Sullivan Sec 1.2 Sullivan Sec 9.2 Sullivan Sec 9.3 Sullivan Sec 9.4**
	Applications of conics • Solving systems of conics • Satellite dishes (parabola) • Orbits, whispering galleries (ellipses) • LOng RAnge Navigation system (LORAN) (hyperbola)		
	1 block – **Suggested assessment, enrichment, and remediation for this unit.**		

Unit 3	**Functions**	**AII.7** The student will investigate and analyze functions algebraically and graphically.	**ESS lessons:**
5 - 6	• One-to-one functions (new) • Inverse Functions • Composition of Functions • Families of Functions • Transformations (connect to graphs and equations) • Domain and range (interval notation) • Even and odd functions (new) • Factoring • Piecewise Functions • Converting between standard form and vertex form (h, k) form		AII.6 – Transformational Graphing - Functions AII.7 – Functions: Domain, Range, End Behavior, Increasing, Decreasing – Functions AII.7 – Inverse Functions - Functions AII.7 – Composition of Function – Functions Precalculus: Inverses of Functions by Texas Instruments
	1 block – **Suggested assessment, enrichment, and remediation for this unit.**		

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
Unit 4 *2-3*	**Introduction to Trigonometry** **Angles** • Define angle, including its initial and terminal sides • Identify the direction of rotation for angles to be positive and negative • Define standard position of an angle, direction of rotation, quadrant in which an angle lies, quadrantal angles, and reference angles • Draw angles of varying measures **Angle Measurements** • Define radian • Use the arc length and area of a sector to solve problems • Convert from radians to degrees and back • Use unit analysis to solve problems involving linear speed, rotational speed and angular speed	**T.3** The student will find, without the use of a calculator, the values of the trigonometric functions of the special angles and their related angles as found in the unit circle. This will include converting angles from radians to degrees and vice versa.	**Sullivan Sec 5.1—5.4, 5.6** **Websites –** **www.funmaths.com/worksheets** **www.analyzemath.com/trigonometry** **www.kutasoftware.com** **www.ti.com** **Tactile Trigonometry (Hands on Trig)**

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills	Additional Instructional Resources

		Essential Understandings	
Unit 4 cont. **6**	**Unit Circle** - Use the concepts of the special right triangles to create the unit circle - Reproduce the unit circle without aid of a calculator - Define the six trigonometric functions - Find the six trigonometric functions a. in terms of the coordinates of any point on the Unit Circle b. using a calculator c. in terms of the coordinates of any point on a circle of radius *r* d. given the coordinates of any point on the terminal side of an angle - Write the following fundamental identities: a. reciprocal identities b. quotient identities c. Pythagorean identities - Solve problems by finding values of the six trigonometric functions a. using even-odd properties to find the exact values of the trigonometric functions b. using fundamental trigonometric identities c. given one of the functions and the quadrant of the angle - Determine the signs of the trigonometric functions in each quadrant	**T.1** The student, given a point other than the origin on the terminal side of the angle, will use the definitions of the six trigonometric functions to find the sine, cosine, tangent, cotangent, secant, and cosecant of the angle in standard position. Trigonometric functions defined on the unit circle will be related to trigonometric functions defined in right triangles. **T.2** The student, given the value of one trigonometric function, will find the values of the other trigonometric functions, using the definitions and properties of the trigonometric functions. **T.3** The student will find, without the use of a calculator, the values of the trigonometric functions of the special angles and their related angles as found in the unit circle. This will include converting angles from radians to degrees and	**Websites –** Unit Circle Demonstration iOS - TRIGO Android - Trig Quizzer Precalculus: Unit Circle by Texas Instruments - Bell Ringer Lesson Gizmos

		vice versa.	
		T.4 The student will find, with the aid of a calculator, the value of any trigonometric function and inverse trigonometric function**.**	

1 block – Suggested assessment, enrichment, and remediation for previous two Unit 4 sections.

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
Unit 4 cont.	**Graphing Trigonometric Functions** • State the domain, range, and periodicity of the	T. 6 The student, given one of the six trigonometric functions in	Exploration Activity Graphing Graphing Trig Project

		standard form, will	

6 -7	trigonometric functions
	
	• Graph the sine and cosine functions as parent functions
	
	   a. identify the properties of the sine and cosine graphs
	
	   b. use the sine and cosine graphs to develop and explain the graphs of the remaining trigonometric functions
	
	• Use knowledge of transformations to graph general form of trigonometric equations in the form $y = A\sin(Bx - C) + D$
	
	   a. describe how changes in amplitude, period, phase shifts, and vertical shifts affect sine and cosine graphs from a practical application standpoint
	
	   b. determine the amplitude, period, phase shift, and vertical shift of trigonometric functions and their graphs
	
	   c. Write a sine or cosine function that satisfies a given data set allowing for amplitude, period, phase shift, and vertical shift
		a) state the domain and the range of the function;
		b) determine the amplitude, period, phase shift, vertical shift, and asymptotes;
		c) sketch the graph of the function by using transformations for at least a two-period interval; and
		d) investigate the effect of changing the parameters in a trigonometric function on the graph of the function.
			Precalculus: Find That Sine by Texas Instruments
			
			Precalculus: Vertical and Phase Shifts by Texas Instruments
			
			Shrinking Candles, Running Water, Folding Boxes

1 block – **Suggested assessment,** **enrichment, and remediation for graphing**
trigonometric functions.

Suggest Semester Break
Maximum 39 blocks

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
Unit 4 cont. **5**	**Inverse Trigonometric Functions** • Define the inverse of each of the six trigonometric functions, to include restricted domain and range • Find the exact value of the inverse trigonometric functions using • graphing calculators • unit circle • composite trigonometric functions	**T.4** The student will find, with the aid of a calculator, the value of any trigonometric function and inverse trigonometric function. **T.7** The student will identify the domain and range of the inverse trigonometric functions and recognize the graphs of these functions. Restrictions on the domains of the inverse trigonometric functions will be included.	Desmos: Intro to Inverse Trig Functions Problem Set – Quarter 3 Problem Set – Quarter 4
	1 block – **Suggested assessment, enrichment, and remediation for this topic.**		

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
Unit 4 cont. **3 - 4**	**Identities** • Establish/verify trigonometric identities	**T.5** The student will verify basic trigonometric identities and make substitutions, using the basic identities.	Precalculus: Trig Proofs by Texas Instruments

5	**Solve trigonometric** equations using
	Include finite and infinite number of solutions
	   a. Sum and difference formulas
	   b. Double and half angle formulas
	   c. Graphing
	   d. Factoring
		T.8 The student will solve trigonometric equations that include both infinite solutions and restricted domain solutions and solve basic trigonometric inequalities.	Gizmos

3-4	**Applications of Trigonometric Functions**
	• Solve right triangles
	• Solve oblique triangles using
	   a. Law of Sines (Include ambiguous case)
	   b. Law of Cosines
	• Find the area of triangles using
	   a. Heron's formula
	• Two sides and the sine of the included angle
		MA.13 (T. 9) The student will identify, create, and solve real-world problems involving triangles. Techniques will include using the trigonometric functions, the Pythagorean Theorem, the Law of Sines, and the Law of Cosines.	Exploration/Discovery Law of Sines
			
			Gizmos — **Proving Triangles Congruent - Choose "SSA". Discuss conditions for Counterexample.**

	2 blocks – **Suggested assessment, enrichment, and remediation for this unit.**		

Number	Topics and Essential Questions	Standard(s) of Learning	Additional Instructional

of Blocks		Essential Knowledge and Skills Essential Understandings	Resources

Unit 5
 	
5-7
	Polynomial and Rational Functions
	• Polynomial functions
	  a. Identify the domain, range, zeros of a function, the x and y intercepts, intervals where the function is increasing and decreasing, and end behavior, graphically and algebraically. Express characteristics in interval notation.
	  b. Explore why discontinuities do not occur in polynomial functions.
	  c. Describe relationships among solutions, zeros, x-intercepts, and factors of higher order polynomial functions.
	  d. Review factoring (sum/difference cubes, Sum/difference squares, grouping, trinomials with lead coefficient $\neq 1$)
	  e. Solve polynomials graphically and algebraically using a variety of methods including factoring, long division, and synthetic division.
	  f. Write equations of polynomials given various characteristics of the function.
	
	• Rational functions
	  a. Investigate and analyze rational functions graphically first, then algebraically.
	  b. Identify the domain, range, zeros of a function, the x and y intercepts, intervals where the function is increasing and decreasing, asymptotes (horizontal, vertical, & slant or
		MA.1 The student will investigate and identify the characteristics of polynomial and rational functions and use these to sketch the graphs of the functions. This will include determining zeros, upper and lower bounds, y-intercepts, symmetry, asymptotes, intervals for which the function is increasing or decreasing, and maximum or minimum points. Graphing utilities will be used to investigate and verify these characteristics.	[Angry Bird Parabola Project](#)
			
			[Birthday Polynomial Rational Function Project](#)
			
			[Building Connections](#)
			
			[Shrinking Candles, Running Water, Folding Boxes](#)

	oblique) and other discontinuities, and end behavior, graphically and algebraically. Express characteristics in interval notation. c. Review simplifying complex fractions and operations as necessary. d. Solve rational equations and inequalities graphically and algebraically using a variety of methods. e. Write equations of rational functions given various characteristics of the function.		
1 block – **Suggested assessment, enrichment, and remediation for this unit.**			

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
Unit 6 **3**	**Exponential and Logarithmic Functions** • Rewrite exponential expressions as logarithmic expressions and vice versa • Evaluate exponential and logarithmic expressions • Apply properties of logarithms to express in expanded/condensed form • Use the change of base formula to evaluate logarithms whose base in neither 10 nor e	**MA.9** The student will investigate and identify the characteristics of exponential and logarithmic functions in order to graph these functions and solve equations and real-world problems. This will include the role of e, natural and common logarithms, laws of exponents and logarithms, and the solution of logarithmic and exponential equations.	**Websites –** www.kutasoftware.com www.onlinemathlearning.com/**exponential-logarithmic**.html www.analyzemath.com **Sullivan Sec 4.2** **Sullivan Sec 4.6** **Sullivan Sec 4.7** **Sullivan Sec 4.8** Precalculus: Accelerated Returnsby Texas Instruments Precalculus: Can You Hear Me Now?by Texas Instruments Shrinking Candles, Running Water, Folding Boxes
6	**Solving Exponential and Logarithmic Equations** • Comparing arguments when the bases match • Rewriting as an exponential or logarithmic equation • Using the change of base formula • Solve exponential and logarithmic equations using algebraic and graphic methods. (Emphasis is to be given to checking solutions for extraneous solutions in the domain)		
	Applications • Determine the future value or present value of a lump sum of money • Determine the time required for a lump sum of money to double or triple • Find equations of populations that obey the law of decay/growth • Use Newton's Law of Cooling • Logistic Growth Models • Use a graphing utility to fit data to an exponential function • Use a graphing utility to fit data to a logarithmic function		
	1 block – **Suggested assessment, enrichment, and remediation for this unit.**		

Number of Blocks	Topics and Essential Questions	Standard(s) of Learning Essential Knowledge and Skills Essential Understandings	Additional Instructional Resources
Unit 7 6	**Sequences and Series** • Sigma Notation • Arithmetic, Geometric, Infinite Geometric • Explicit vs Recursive Formulas • Applications • Mathematical Induction • The Binomial Theorem (include Pascal's Triangle) ○ Stress binomials expansion to the 2nd and 3rd power. (Pascal's Triangle etc.)	**MA.5** The student will find the sum (sigma notation included) of finite and infinite convergent series, which will lead to an intuitive approach to a limit. **MA.4** The student will expand binomials having positive integral exponents through the use of the Binomial Theorem, the formula for combinations, and Pascal's Triangle. **MA.6** Compare inductive and deductive reasoning. Prove formulas/statements, using mathematical induction. Mathematical induction is a method of proof that depends on a recursive process. Mathematical induction allows reasoning from specific true values of the variable to general values of the variable	**Sullivan Sec 11.1** **Sullivan Sec 11.1 – 11.3** **Sullivan Sec 11.4** **Sullivan Sec 11.5** Arithmetic Sequence Discovery Precalculus: Infinite Geometric Series by Texas Instruments Recursive and Exponential Rules Algebra II: Arithmetic Sequences & Series by Texas Instruments
1 block – **Suggested assessment, enrichment, and remediation for this unit.**			

Number	Topics and Essential Questions	Standard(s) of Learning	Additional Instructional

of Blocks		Essential Knowledge and Skills Essential Understandings	Resources
Unit 8 **If time** **allows** **2**	**LIMITS** **Finding Limits by Inspection** • Find a limit numerically (using a table of values) • Find a limit graphically • Find the limit of a polynomial • Find the limit of a power or root	**MA.7** The student will find the limit of an algebraic function, if it exists, as the variable approaches either a finite number or infinity. A graphing utility will be used to verify intuitive reasoning, algebraic methods, and numerical substitution.	**Websites –** http://www.coolmath.com/lesson-whats-a-limit-1.htm http://www.analyzemath.com/calculus/limits/introduction.html http://www.analyzemath.com/calculus_worksheets/limits/limit_1.pdf http://www.themathpage.com/aCalc/limits.htm http://www.sosmath.com/calculus/limcon/limcon04/limcon04.html <mark>Improving Archimedes' Method</mark>
2	**Finding Limits Analytically** • Find a limit by simplifying rational expressions, adding fractions, multiplying numerator and denominator by a conjugate • Find one-sided limits of a function (numerically, graphically, analytically) • Find limits at infinity (numerically, graphically, analytically)		
2	**Application of Limits** • Use limits to determine if a function is continuous at a point • Find the limit of an average rate of change • Write the equation of the tangent line to a graph at a point		
2	**Using Graphing Utilities** • Use a graphing utility to find a limit numerically and graphically • Use a graphing utility to verify the equation of the tangent line to a graph at a point		
<mark>1 block – **Suggested assessment, enrichment, and remediation for this unit.**</mark>			

Additional information about math vocabulary can be found in the

[VDOE Vocabulary Word Wall Cards](#)

(click link above)