Precalculus & Trigonometry

Course Description and Competencies for Precalculus (4611) and Trigonometry (4750)

Course Description

Precalculus & Trigonometry are fourth mathematics course options for students in preparation for calculus. Students build on the conceptual knowledge and skills they mastered in previous mathematics courses in Pre-Kindergarten through, Algebra I, Geometry, and Algebra II. These courses combine concepts of trigonometry, geometry, and functions to deepen students' mathematical understanding and fluency. Students will extend their ability to reason mathematically, develop multiple strategies for analyzing complex mathematical situations, and explore real-world problems.

Vision and Guiding Principles

The Precalculus and Trigonometry competencies are written with the same guiding principles as the *Oklahoma Academic Standards for Mathematics* and support students in the development of the Mathematical Actions and Processes outlined in the standards. The Precalculus and Trigonometry competency writing team also utilized researched best-practices, current Oklahoma college-level course syllabi, state-level standards and competencies, NCTM's *Principles to Actions*, and NCTM's *Essential Standards for High School Mathematics* to create the Precalculus and Trigonometry competencies below.

Developing mathematical proficiency and literacy for Oklahoma students depends in large part on a clear, comprehensive, coherent, and developmentally appropriate set of competencies to guide curricular decisions. The understanding and implementation of these competencies and standards throughout PK-12 mathematics experience for students is based on the following guiding principles:

- *Guiding Principle 1:* Excellence in mathematics education requires equity—high expectations and strong support for all students.
- *Guiding Principle 2:* Mathematical ideas should be explored in ways that stimulate curiosity, create enjoyment of mathematics, and develop depth of understanding.
- *Guiding Principle 3:* An effective mathematics program focuses on problem solving.
- *Guiding Principle 4:* Technology is essential in teaching and learning mathematics.

The Precalculus and Trigonometry competencies envision all students in Oklahoma will become mathematically proficient and literate through an emphasis on problem solving, communicating, reasoning, justifying, making connections, and using representations. Mathematically proficient and literate students can confidently and effectively use mathematics concepts, computation skills, and numbers to problem-solve, reason, and analyze information.

Precalculus and Trigonometry Competencies

Oklahoma Mathematical Actions and Processes

*The incorporation of the **Oklahoma Mathematical Actions and Processes**[1] were identified to be essential in the overall progression of PK-12 mathematics education. In the implementation of the included competencies, it is essential to connect students to the holistic nature of mathematics that is represented within the Mathematical Actions and Processes. Throughout their PK-12 education experience, mathematically literate students will:*

Develop a Deep and Flexible Conceptual Understanding. Demonstrate a deep and flexible conceptual understanding of mathematical concepts, operations, and relations while making mathematical and real-world connections.

Develop Accurate and Appropriate Procedural Fluency. Pursue efficient procedures for various computations and repeated processes based on a strong sense of numbers. They will develop a sophisticated understanding of the development and application of algorithms and procedures.

Develop Strategies for Problem Solving. Analyze the parts of complex mathematical tasks and identify entry points to begin the search for a solution. They will select from a variety of problem solving strategies and use corresponding multiple representations (verbal, physical, symbolic, pictorial, graphical, tabular) when appropriate. They will pursue solutions to various tasks from real-world situations and applications that are often interdisciplinary in nature. They will find methods to verify their answers in context and will always question the reasonableness of solutions.

Develop Mathematical Reasoning. Explore and communicate a variety of reasoning strategies to think through problems. They will apply their logic to critique the thinking and strategies of others to develop and evaluate mathematical arguments, including making arguments and counterarguments and making connections to other contexts.

Develop a Productive Mathematical Disposition. Hold the belief that mathematics is sensible, useful and worthwhile. They will develop the habit of looking for and making use of patterns and mathematical structures. They will persevere and become resilient, effective problem solvers.

Develop the Ability to Make Conjectures, Model, and Generalize. Make predictions and conjectures and draw conclusions throughout the problem solving process based on patterns and the repeated structures in mathematics. They will create, identify, and extend patterns as a strategy for solving and making sense of problems.

Develop the Ability to Communicate Mathematically. Discuss, write, read, interpret and translate ideas and concepts mathematically. As they progress, students' ability to communicate mathematically will include their increased use of mathematical language and terms and analysis of mathematical definitions.

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[1] The Mathematical Actions and Processes were included in the 2015 revisions of the Oklahoma Academic Standards for Mathematics. Each of the seven components is based on the Process Standards produced by the National Council of Teachers of Mathematics in 2000 and the interwoven strands of Mathematical Proficiency identified in the 2001 National Research Council report, Adding it Up.

Precalculus & Trigonometry Competencies (PC)

Functions (F)

Reasoning with functions involves students extending applications of functions beyond skills developed in Algebra 2. It provides students with opportunities to extend the behavior of functions and relations by using multiple representations and covariational reasoning to investigate and explore quantities, their relationships, and how these relationships change.

PC.F.1 Students will analyze functions and relations.

PC.F.1.1 Interpret parameters of a function defined by an expression in the context of the situation.

PC.F.1.2 Sketch the graph of a function that models a relationship between two quantities, identifying key features.

PC.F.1.3 Interpret key features of graphs and tables for a function that models a relationship between two quantities in terms of the quantities.

PC.F.1.4 Describe end behavior, asymptotic behavior, and points of discontinuity using limits.

PC.F.1.5 Determine if a function has an inverse. Algebraically and graphically find the inverse or define any restrictions on the domain that meet the requirement for invertibility, and find the inverse on the restricted domain.

PC.F.2 Students will build functions to model and validate relationships among functions.

PC.F.2.1 Model relationships between quantities that require adding, subtracting, multiplying, and/or dividing functions.

PC.F.2.2 Model relationships through composition and attend to the restrictions of the domain.

PC.F.2.3 Rewrite a function as a composition of functions.

PC.F.2.5 Interpret the meanings of quantities involving functions and their inverses.

PC.F.2.6 Verify by analytical methods that one function is the inverse of another.

PC.F.3 Students will predict and verify solutions involving functions.

PC.F.3.1 Predict solutions involving functions that are quadratic, polynomial of higher order, rational, exponential, and logarithmic.

PC.F.3.2 Graphically verify solutions involving functions that are quadratic, polynomial of higher order, rational, exponential, and logarithmic.

PC.F.3.3 Algebraically verify solutions involving functions that are quadratic, polynomial of higher order, rational, exponential, and logarithmic.

Conic Sections (CS)

Reasoning with Conic Sections involves determining, analyzing, and writing equations for the conic sections formed when a plane intersects a double-napped cone. Concepts are incorporated into both mathematical and real-world problem situations.

PC.CS Students will investigate conic sections.

PC.CS.1 Model real-world situations which involve conic sections.
PC.CS.2 Identify key features of conic sections (foci, directrix, radii, axes, asymptotes, center) graphically and algebraically.
PC.CS.3 Sketch a graph of a conic section using its key features.
PC.CS.4 Write the equation of a conic section given key features.
PC.CS.5 Given the equation $ax^2 + by^2 + cx + dy + e = 0$, determine if the equation is a circle, ellipse, parabola, or hyperbola.

Trigonometry (T)

Reasoning with Trigonometry involves students extending their mathematical understandings beyond the skills learned in Geometry and Algebra 2. Students will have the opportunity to extend their trigonometric reasoning and knowledge to non-right triangles and the Polar Coordinate system and will make sense of the Law of Sines and Law of Cosines in real-world situations.

PC.T.1 Students will make sense of the unit circle and its relationship to the graphs of trigonometric functions.

PC.T.1.1 Draw and recognize angles in standard position using radian measure, and determine the quadrant of the terminal side.
PC.T.1.2 Convert radian measure to degree measure and vice-versa.
PC.T.1.3 Find the length of an arc and the area of a sector on a circle.
PC.T.1.4 Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.
PC.T.1.5 Use reference angles to determine the terminal point $P(x,y)$ on the unit circle for a given angle.
PC.T.1.6 Estimate trigonometric values of any angle.
PC.T.1.7 Apply the properties of a unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.
PC.T.1.8 Graph of all six trigonometric functions, identifying key features.
PC.T.1.9 Describe and analyze the relationships of the properties of a unit circle.

PC.T.2 Students will apply trigonometric concepts beyond the right triangle.

PC.T.2.1 Model real-world situations involving trigonometry.
PC.T.2.2 Apply the Law of Sines and Law of Cosines to solve problems.
PC.T.2.3 Use trigonometry to find the area of triangles.
PC.T.2.4 Use inverse functions to solve trigonometric equations utilizing real world context; evaluate the solution and interpret them in terms of context.

Trigonometry (T): *continued*

PC.T.3 Students will verify trigonometric identities and solve equations.

PC.T.3.1 Algebraically manipulate the structure of a trigonometric expression to identify ways to rewrite it.
PC.T.3.2 Choose and produce an equivalent form of an expression to explain the properties of the quantity represented by the expression.
PC.T.3.3 Graphically and algebraically verify solutions to trigonometric equations.

PC.T.4 Students will explore complex numbers and polar equations.

PC.T.4.1 Use the relation $i^2 = -1$ and the mathematical properties to add, subtract, and multiply complex numbers.
PC.T.4.2 Find the conjugate of a complex number in rectangular and polar forms and quotients of complex numbers.
PC.T.4.3 Solve quadratic equations in one variable that have complex solutions.
PC.T.4.4 Explain why complex roots of polynomials with real coefficients must occur in conjugate pairs.
PC.T.4.5 Graph polar equations.
PC.T.4.6 Analyze and interpret the graphs of polar equations.
PC.T.4.7 Use polar equations to solve, analyze, and verify solutions.

Vectors and Parametrics (V)

Reasoning with Vectors involves recognizing that a vector consists of both magnitude and direction. Students should understand that motion in space, such as velocity, can be represented by a vector. Students should be proficient using appropriate symbols to represent vectors and their magnitudes. Furthermore, students should be able to determine a vector from its initial point and terminal point, add and subtract vectors, and multiply a vector by a scalar.

PC.V.1 Students will model with parametrics.

PC.V.1.1 Model real-world contexts with parametric equations.
PC.V.1.2 Use parametric equations to solve problems.
PC.V.1.3 Graph parametric equations to solve problems.
PC.V.1.4 Analyze and interpret the graphs of parametric equations.
PC.V.1.5 Convert between parametric and rectangular representations.

PC.V.2 Students will explore and solve problems with vectors.

PC.V.2.1 Recognize vector quantities as having both magnitude and direction.
PC.V.2.2 Represent vector quantities by directed line segments, and use appropriate symbols for vector and their magnitudes.
PC.V.2.3 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
PC.V.2.4 Solve problems involving velocity and other quantities that can be represented by vectors.
PC.V.2.5 Add and subtract vectors, and multiply a vector by a scalar.

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Questions about this document?

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