Seymour Public Schools Curriculum

The Mathematics Department believes its students must learn the importance of mathematics, the integration of different branches of mathematics, the application of math to real-life problems, and the connections between mathematics and other disciplines. This course is concerned with developing the students' understanding of the concepts of trigonometry and providing experience with its methods and applications in order to prepare students for study of higher mathematics.

In this unit, relations, functions, and the distance formula are discussed and related to graphs in the coordinate plane. A smooth transition is thus provided for defining the six trigonometric functions using the concept of rotation around the unit circle. Trigonometric functions of special angles as well as evaluating trigonometric functions using a calculator are presented. A number of application problems are introduced and solved throughout the unit.

Grade: 11-12	**Trigonometry** **Trigonometric Functions**
Common Core Standards	F-IF Interpreting Functions F-TF Trigonometric Functions G-SRT Similarity, Right Triangles, and Trigonometry G-C Circles
Enduring Understanding	Trigonometric functions can be expressed as a ratio of the sides of a right triangle. The values of trigonometric functions exhibit periodic behavior.
Essential Questions	What is the relationship between angles and sides of a triangle? How can trigonometric values of an angle be evaluated?
Content Standards:	**Understand the concept of a function and use function notation** F-IF-1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f*(*x*) denotes the output of *f* corresponding to the

input x. The graph of f is the graph of the equation $y = f(x)$.

Analyze functions using different representations

F-IF-7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

Extend the domain of trigonometric functions using the unit circle

F-TF-1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF-2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

F-TF-3 (+) 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.

Define trigonometric ratios and solve problems involving right triangles

G-SRT-6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT-8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Find arc lengths and areas of sectors of circles

G-C-5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

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Performance Expectations (Student outcomes)	At the completion of this unit, students will be able to: • identify and define relations and functions. • graph functions in the coordinate plane. • define and use the distance formula. • measure angles in rotation and degrees. • convert to and use angle measures in degrees-minutes-seconds. • find the measures of coterminal angles. • measure angles and arcs in degrees and in radians. • convert between radian measure and degree measure. • solve problems involving arc length, angular velocity, and linear velocity. • define sine and cosine functions. • evaluate the sine and cosine functions of an angle given a point on its terminal side. • define the tangent, cotangent, secant, and cosecant functions. • evaluate the trigonometric functions of an angle. • find the values of the six trigonometric functions of the geometric special right triangles. • give decimal approximations for the values of the six trigonometric functions for any angle. • find the measure of an angle given the value of one of its trigonometric functions.

Strategies/Modes (examples)	**Materials/Resources (examples)**	**Assessments (examples)**
• Guided practice • Worksheets • Homework • Cooperative Group work • Quizzes • Tests • Projects • Math Labs	Advanced Mathematics (Richard Brown) Trigonometry (Jerome Hayden) Trigonometry (Margaret Lial)	• homework assignments • quizzes • tests • alternative assessments

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This unit begins with a development of the graphs of the sine and cosine functions, including those involving a change in amplitude and/or period, a phase shift, and/or a vertical shift. The graphs of the other four trigonometric functions are then introduced and developed. Applications that address the phenomenon of simple harmonic motion are solved throughout the unit.

Grade: 11-12	**Trigonometry** **Graphing Trigonometric Functions**
Common Core Standard	F-TF Trigonometric Functions
Enduring Understanding	Trigonometric functions model many real world situations.
Essential Questions	How can a periodic function be used as a model of real world phenomena? How can we evaluate these periodic functions to make predictions of future events? How do amplitudes, periods, and phase shifts affect the graph of a trigonometric function?
Content Standards:	**Extend the domain of trigonometric functions using the unit circle** F-TF-4 (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. **Model periodic phenomena with trigonometric functions** F-TF-5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.
Performance Expectations (Student outcomes)	At the completion of this unit, students will be able to: • define periodic functions and odd and even functions. • determine the symmetry of a graph. • develop the properties of the sine and cosine functions.

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	• graph the basic sine and cosine functions. • find the amplitude and period of a trigonometric function from its graph and its equation. • graph the sine and cosine functions with varied amplitudes and periods. • find the phase shift and vertical shift of graphs of the sine and cosine from their graphs and their equations. • graph sine and cosine functions with varied phase and vertical shifts. • graph functions that are the sums or differences of two sine and/or cosine functions. • determine the properties of the tangent and cotangent functions. • graph the tangent and cotangent functions. • determine the properties of the secant and cosecant functions. • graph the secant and cosecant functions. • solve problems involving simple harmonic motion.

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Right triangle trigonometry is introduced in this unit and then used to find unknown side lengths or angle measurements. The concepts of angles of elevation or depression are developed and used in a variety of real-world problems.

Grade: 11-12	**Trigonometry** **Right Triangle Trigonometry**
Common Core Standard	G-SRT Similarity, Right Triangles, and Trigonometry
Enduring Understanding	Trigonometric relationships (ratios and formulas) can be used to solve real world problems.
Essential Questions	How can triangle trigonometry be used to solve problems in real world situations? How are geometric trigonometry and circular trigonometry related?
Content Standard:	**Define trigonometric ratios and solve problems involving right triangles** G-SRT-8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
Performance Expectations (Student outcomes)	At the completion of this unit, students will be able to: • solve right triangle problems given the measures of one angle and one side or given the measures of two sides. • define and use angles of elevation and depression. • solve real-world problems using trigonometry.

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The fundamental reciprocal, ratio, Pythagorean, and odd-even identities are defined and proved. These identities are then used to simplify complex trigonometric expressions. Technology is also used to prove identities as well as the traditional method of simplifying independently one or both sides of the identity.

Grade: 11-12	**Trigonometry** **Basic Identities**
Common Core Standard	F-TF Trigonometric Functions
Enduring Understanding	Complex trigonometric expressions and equations can be expressed in a more simple form by using proven identities and relationships.
Essential Questions	What is an identity? When is it appropriate to express a statement using identities? How is an identity proven?
Content Standards:	**Extend the domain of trigonometric functions using the unit circle** F-TF-4 (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. F-TF-8 Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.
Performance Expectations (Student outcomes)	At the completion of this unit, students will be able to: • introduce and prove reciprocal, ratio, Pythagorean, and odd-even identities. • use the fundamental identities to write equivalent trigonometric expressions. • use the fundamental identities to prove other identities. • check identities by graphing both sides of the equations.

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This unit involves the study of triangles that are not right (oblique) triangles. The laws of sines is proved then used to solve triangles when the measures of two angles and one side are known. Since it is not always possible to solve a triangle using the law of sines (the ambiguous case), the conditions for which it is possible are discussed. The laws of cosines and tangents, as well as Heron's formula for finding the area of a triangle, are also proved and used within this unit.

Grade: 11-12	**Trigonometry** **Oblique Triangles**
Common Core Standards	F-TF Trigonometric Functions G-SRT Similarity, Right Triangles, and Trigonometry
Enduring Understanding	Functions in trigonometry can be applied to triangles that are not right triangles.
Essential Questions	How can values of sine, cosine, and tangent be found for angles that not within a right triangle? How are oblique formulas helpful in the solving of real world problems? Do they always work?
Content Standards:	**Extend the domain of trigonometric functions using the unit circle** F-TF-3 (+) 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. **Apply trigonometry to general triangles** G-SRT-9 (+) Derive the formula $A = 1/2\ ab\ \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. G-SRT-10 (+) Prove the Laws of Sines and Cosines and use them to solve problems. G-SRT-11 (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

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Performance Expectations (Student outcomes)	At the completion of this unit, students will be able to: • introduce and prove the law of sines. • use the law of sines to solve triangles when the measures of two angles and one side are known. • solve a triangle when the measures of two sides and an angle opposite one of them are given. • introduce and prove the law of cosines. • use the law of cosines to solve triangles when the measures of two sides and the included angle or the measures of the three sides are known. • introduce and prove the law of tangents. • use the law of tangents to solve triangles when the measures of two sides and the included angle are known. • find the area of a triangle when the measures of two sides and the included angle are known. • use the law of sines to find the area of a triangle when the measures of one side and two angles are known. • use Heron's formula to find the area of a triangle and the length of an altitude when the lengths of three sides are known.

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The focus of this unit is on the development of the sum and difference identities for cosine, sine, and tangent of a sum or a difference of two angles. These identities provide a smooth transition to double-angle, half-angle, and product/sum identities that are used in evaluating expressions and proving more complex identities.

Grade: 11-12	**Trigonometry** **Trigonometric Identities**
Common Core Standard	F-TF Trigonometric Functions
Enduring Understanding	More complex identities and formulas can be used to solve difficult problems or evaluate non-common angle measures.
Essential Questions	How are half-angle and double-angle formulas used to evaluate the trigonometric functions for non-special right triangle measures? How can these formulas and identities help in simplifying more complex expressions?
Content Standards:	**Extend the domain of trigonometric functions using the unit circle** F-TF-8 Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle. F-TF-9 (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
Performance Expectations (Student outcomes)	At the completion of this unit, students will be able to: • develop and use formulas for the cosine, sine, or tangent of a sum or difference of two angle measures. • develop and use double-angle, half-angle, and product/sum identities. • prove more complex identities.

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Assessments (examples)
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Inverses of functions are the focus of this unit. Initially the fundamental relationship between a function and its inverse are examined before introducing the inverses of the six trigonometric functions. The limits placed upon the domains of each of the functions are discussed as well as their principal values. Trigonometric equations are solved for their exact and approximate solutions and a discussion of the rotation of axes as it applies to trigonometry is discussed.

Grade: 11-12	**Trigonometry** **Inverse Trigonometric Functions**
Common Core Standard	F-TF Trigonometric Functions
Enduring Understanding	Identities and inverse functions are used in solving trigonometric equations.
Essential Questions	Why are the quadrants used for inverse trigonometric functions limited? \How are inverse functions used to solve trigonometric equations?
Content Standard:	**Model periodic phenomena with trigonometric functions** F-TF-7 (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.
Performance Expectations (Student outcomes)	At the completion of this unit, students will be able to: • graph functions and relations and their inverses. • evaluate arcsin and arccos expressions • define the inverse sine and cosine functions. • evaluate expressions involving Arcsine and Arccosine. • define the inverse and evaluate expressions involving the inverse of tangent, cotangent, secant, and

	cosecant. • solve trigonometric equations for exact solutions. • find approximate solutions to trigonometric equations. • derive and use formulas for rotations of axes. • graph equations using rotated axes.

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