Saint Patrick High School

Curriculum Guide

Department:	Mathematics	**Grade and Level:**	11 or 12 Honors
Class:	H PreCalculus	**Term (Semester or Year):**	Year-long Course

Required Text:	• Larson Algebra and Trigonometry, 9th edition
Additional Resources (i.e. texts, materials, apps, etc.):	iPad Apps Showbie GoodReader iBooks iTunes U Educreations Nearpod Materials Binder LooseLeaf Note Packets Pencil TI-84 Plus Graphing Calculater

Course Description

This course aims to expand on topics learned in previous courses on Algebra and Trigonometry in preparation for a Calculus course. The year will begin with a review of algebraic topics encountered in a first year algebra course. Topics covered in the course include functions and graphs, complex numbers, quadratic models, polynomial functions and operations, rational functions and asymptotes, conics, exponential and logarithmic functions, analytic trigonometry, vectors, systems, and matrices. Logical thinking will be practiced in formulating basic mathematical skills in problem solving and applying concepts. There will be an emphasis on ACT Exam Preparation.

Unit Themes (Table of Contents)

Theme 1:	Prerequisites
Theme 2:	Equations, Inequalities, and Mathematical Modeling
Theme 3:	Functions and Their Graphs
Theme 4:	Polynomial Functions
Theme 5:	Rational Functions
Theme 6:	Exponential and Logarithmic Functions
Theme 7:	Trigonometry
Theme 8:	Analytic Trigonometry
Theme 9:	Additional Topics in Trigonometry
Theme 10:	Matrices and Determinants
Theme 11:	Conics and Vectors
Theme 12:	Sequences, Series and Probability

Agreed Upon Assessments

Forms of assessments may include but are not limited to….

- Mid Chapter Quizzes
- Unit Exams
- Lectures/Discussions
- Group Projects
- Presentations
- Homework Assignments
- Homework Quizzes

Research and Writing Expectations

- Students are required to write detailed solutions to the exercises that they solve
- Analysis questions are also presented, where students are required to explain why a given statement or solution is true or false

Unit 1: Prerequisites

Essential Questions:

- What algebra topics are fundamental to precalculus?

Learning Targets:

Students will be able to…:

- Represent and classify real numbers
- Order real numbers and use inequalities
- Find the absolute values of real numbers and find the distance between two real numbers
- Evaluate algebraic expressions
- Use the basic rules and properties of algebra
- Use properties of exponents
- Use scientific notation to represent real numbers
- Use properties of radicals to simplify and combine radicals
- Rationalize denominators and numerators
- Use properties of rational exponents
- Write polynomials in standard form and add subtract and multiply them.
- Use special products to multiply polynomials
- Use polynomials to solve real-life problems
- Remove common factors from polynomials
- Factor special polynomial forms
- Factor trinomials as the product of two binomials
- Factor by grouping
- Find domains of algebraic expressions
- Simplify rational expressions
- Add, subtract, multiply and divide rational expressions
- Simplify complex fractions and rewrite difference quotients
- Plot points in the Cartesian Plane
- Use the Distance Formula and the Midpoint Formula
- Use a coordinate plane to model and solve real life problems

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSA.SSE.A.1.a*
  Interpret parts of an expression, such as terms, factors, and coefficients.
- *CCSS.Math.Content.HSA.SSE.A.1.b*
  Interpret complicated expressions by viewing one or more of their parts as a single entity.
- *CCSS.Math.Content.HSA.SSE.A.2*
  Use the structure of an expression to identify ways to rewrite it.
- *CCSS.Math.Content.HSA.SSE.B.3.a*
  Factor a quadratic expression to reveal the zeros of the function it defines.
- *CCSS.Math.Content.HSA.SSE.B.3.b*
  Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines
- *CCSS.Math.Content.HSA.APR.A.1*
  Understand that polynomials form a system analogous to the integers, namely, they are closed

under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials
- *CCSS.Math.Content.HSA.APR.C.5*
  (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.
- *CCSS.Math.Content.HSA.APR.D.7*
  (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.
- *CCSS.Math.Content.HSN.RN.A.2*
  Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 1
- Mid Chapter Quiz 1

Unit 2: Equations, Inequalities and Mathematical Modeling

Essential Questions:

- How can real life situations be expressed with mathematics?
- What methods can be used to solve nonlinear equations?
- How can the real numbers be expanded into other number systems?

Learning Targets:

Students will be able to…:
- Sketch graphs of equations and identify x- and y-intercepts
- Use symmetry to sketch graphs of equations
- Write equations of and sketch graphs of circles
- Use graphs of equation in solving real-life problems
- Identify different types of equations
- Solve linear equations in one variable and solve rational equations that lead to linear equations
- Find x- and y- intercepts algebraically
- Use linear equations to model and solve real-life problems
- Use mathematical models to solve real-life problems
- Solve mixture problems
- Use common formulas to solve real-life problems
- Solve quadratic equations by factoring
- Solve equations by extracting square roots
- Solve quadratic equations by completing the square and using the Quadratic Formula
- Use quadratic equations to model and solve real life problems
- Use the imaginary unit to write complex numbers

- Add, subtract and multiply complex numbers
- Use complex conjugates to write the quotient of two complex numbers in standard form.
- Find complex solution of quadratic equations
- Solve polynomial equations of degree three or higher
- Solve radical equations
- Solve rational equations and absolute value equations
- Use nonlinear and nonquadratic models to solve real life problems
- Represent solutions of linear inequalities in one variable
- Use properties of inequalities to create equivalent inequalities and solve linear inequalities in one variable
- Solve absolute value inequalities
- Use inequalities to model and solve real life problems

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSN.CN.A.1*
  Know there is a complex number *i* such that $i^2 = -1$, and every complex number has the form *a* + *bi* with *a* and *b* real.
- *CCSS.Math.Content.HSN.CN.A.2*
  Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
- *CCSS.Math.Content.HSN.CN.A.3*
  (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers
- *CCSS.Math.Content.HSN.CN.C.7*
  Solve quadratic equations with real coefficients that have complex solutions.
- *CCSS.Math.Content.HSN.CN.C.8*
  (+) Extend polynomial identities to the complex numbers.
- *CCSS.Math.Content.HSN.CN.C.9*
  (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials
- *CCSS.Math.Content.HSA.REI.A.2*
  Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
- *CCSS.Math.Content.HSA.REI.D.10*
  Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
- *CCSS.Math.Content.HSA.REI.D.11*
  Explain why the *x*-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 2
- Mid Chapter Quiz 2

Unit 3: Functions and Their Graphs

Essential Questions:

- How can we relate two quantities?
- How can we determine if functions are one-to-one?
- How do graphs of functions relate to their parent functions?

Learning Targets:

Students will be able to…:

- Use slope to graph linear equations in two variables
- Find the slope of a line given two points on the line
- Write linear equations in two variables
- Use slope to identify parallel and perpendicular lines
- Use slope and linear equations in two variables to model and solve real life problems
- Determine whether relations between two variables are functions and use function notation
- Find the domains of functions
- Use functions to model and solve real life problems
- Evaluate difference quotients
- Use the Vertical Line Test for functions
- Find the zeros of functions
- Determine intervals on which functions are increasing or decreasing
- Determine relative minimum and relative maximum values of functions
- Determine the average rates of change of functions
- Identify even and odd functions
- Identify and graph linear, squaring, cubic, square root, reciprocal, step and other piecewise defined functions and recognize graphs of parent functions
- Use vertical and horizontal shifts, reflections and nonrigid transformations to sketch graphs of functions
- Add subtract, multiply, and divide functions
- Find the composition of one function with another function
- Use combinations and compositions of functions to model and solve real life problems
- Find inverse functions informally and verify that two functions are inverses of each other
- Use graphs of functions to determine whether functions have inverses
- Use the Horizontal Line Test to determine if functions are injective
- Find inverse functions algebraically

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSF.IF.A.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 $y = f(x)$.
- *CCSS.Math.Content.HSF.IF.A.2*
  Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

- *CCSS.Math.Content.HSF.IF.B.4*
  For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
- *CCSS.Math.Content.HSF.IF.B.5*
  Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- *CCSS.Math.Content.HSF.IF.B.6*
  Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph
- *CCSS.Math.Content.HSF.IF.C.7*
  Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases
- *CCSS.Math.Content.HSF.BF.A.1.b*
  Combine standard function types using arithmetic operations
- *CCSS.Math.Content.HSF.BF.A.1.c*
  (+) Compose functions.
- *CCSS.Math.Content.HSF.BF.B.3*
  Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
- *CCSS.Math.Content.HSF.BF.B.4*
  Find inverse functions.

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 3
- Mid Chapter Quiz 3

Unit 4: Polynomial Functions

Essential Questions:

- What methods are used to solve nonlinear, nonquadratic equations?

Learning Targets:

Students will be able to…:

- Analyze graphs of quadratic functions
- Write quadratic functions in standard form and use the results to sketch graphs of functions
- Find minimum and maximum values of quadratic functions in real life applications
- Use transformations to sketch graphs of polynomial functions
- Use Leading Coefficient Test to determine the end behaviors of graphs of polynomial functions
- Find and use the real zeros of polynomial functions as sketching aids

- Use the IVT to help locate the real zeros of polynomial functions
- Use long division to divide polynomials
- Use synthetic division to divide polynomials
- Use the Remainder Theorem and the Factor Theorem
- Use the Fundamental Theorem of Algebra to determine the number of zeros of polynomial functions
- Find rational zeros of polynomial functions
- Find conjugate pairs of complex zeros
- Find zeros of polynomial by factoring
- Use Descartes' Rule of Signs and the Upper and Lower Bound Rules to find zeros of polynomials
- Use mathematical models to approximate sets of data points
- Write mathematical models for direct variation, inverse variation, combined variation and joint variation

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSF.IF.C.7.a*
  Graph linear and quadratic functions and show intercepts, maxima, and minima
- *CCSS.Math.Content.HSF.IF.C.7.c*
  Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
- *CCSS.Math.Content.HSA.APR.B.2*
  Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.
- *CCSS.Math.Content.HSA.APR.B.3*
  Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 4
- Mid Chapter Quiz 4

Unit 5: Rational Functions

Essential Questions:

- What are the properties of a rational function?
- How can we graph a rational function?

Learning Targets:

Students will be able to…:

- Find the domains of rational functions

- Find the vertical and horizontal asymptotes of graphs of rational functions
- Use rational functions to model and solve real life problems
- Sketch the graphs of rational functions
- Sketch the graphs of rational functions that have slant asymptotes
- Use the graphs of rational functions to model and solve real life problems.

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSF.IF.C.7.d*
  (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
- *CCSS.Math.Content.HSA.APR.D.6*
  Rewrite simple rational expressions in different forms; write $^{a(x)}/_{b(x)}$ in the form $q(x) + {}^{r(x)}/_{b(x)}$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.
- *CCSS.Math.Content.HSA.APR.D.7*
  (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 5
- Mid Chapter Quiz 5

Unit 6: Exponential and Logarithmic Functions

Essential Questions:

- What can be modeled using exponential functions?
- What can be modeled using logarithmic functions?
- How are exponential and logarithmic functions related?
- What methods can be used to solve exponential or logarithmic equations?

Learning Targets:

Students will be able to…:

- Recognize and evaluate exponential functions with base *a*
- Graph exponential functions and use the One to One Property
- Recognize, evaluate and graph exponential functions with base *e*
- Use exponential functions to model and solve real life problems
- Recognize and evaluate logarithmic functions with base *a*
- Graph logarithmic functions and recognize, evaluate and graph natural logarithmic functions
- Use logarithmic functions to model and solve real life problems

- Use the change of base formula to rewrite and evaluate logarithmic expressions
- Use properties of logarithms to evaluate, rewrite, expand or condense logarithmic expressions
- Use logarithmic functions to model and solve real life problems
- Solve simple exponential and logarithmic equations
- Solve more complicated exponential and logarithmic equations
- Use exponential and logarithmic equations to model and solve real life problems
- Recognize the five most common types of models involving exponential and logarithmic functions
- Use exponential growth and decay functions to model and solve real life problems
- Use Gaussian functions, logistic growth functions and logarithmic functions to model and solve real life problems

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSA.SSE.A.1.b*
  Interpret complicated expressions by viewing one or more of their parts as a single entity
- *CCSS.Math.Content.HSA.SSE.A.2*
  Use the structure of an expression to identify ways to rewrite it.
- *CCSS.Math.Content.HSA.SSE.B.3.c*
  Use the properties of exponents to transform expressions for exponential functions.
- *CCSS.Math.Content.HSF.LE.A.1.c*
  Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
- *CCSS.Math.Content.HSF.LE.A.2*
  Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table)
- *CCSS.Math.Content.HSF.LE.A.3*
  Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
- *CCSS.Math.Content.HSF.LE.A.4*
  For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology
- *CCSS.Math.Content.HSF.IF.C.7.e*
  Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude
- *CCSS.Math.Content.HSF.IF.C.8.b*
  Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)12^t$, $y = (1.2)^t/10$, and classify them as representing exponential growth or decay.

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 6
- Mid Chapter Quiz 6

Unit 7: Trigonometry

Essential Questions:

- How can angles be measured?
- How do periodic and trigonometric functions model real life situations?
- What methods can be used to graph trigonometric functions?
- How are trigonometric functions related to one another?

Learning Targets:

Students will be able to…:

- Describe angles
- Use degree measure and radian measure
- Convert between degrees and radians
- Use angles to model and solve real life problems
- Evaluate trigonometric functions of acute angles
- Use a calculator to evaluate trigonometric functions
- Use the fundamental trigonometric identities
- Use trigonometric functions to model and solve real life problems
- Evaluate trigonometric functions of any angle
- Use reference angles to evaluate trigonometric functions
- Evaluate trigonometric functions of real numbers
- Sketch graphs of sine and cosine using amplitude and period
- Sketch translations of the graphs of sine and cosine functions
- Use sine and cosine functions to model real life data
- Sketch the graphs of tangent, cotangent, secant and cosecant functions
- Sketch the graphs of damped trigonometric functions
- Evaluate and graph inverse trigonometric functions
- Evaluate the compositions of trigonometric functions
- Solve real life problems involving right triangles
- Solve real life problems involving directional bearings
- Solve real life problems involving harmonic motion

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSG.SRT.C.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.
- *CCSS.Math.Content.HSG.SRT.C.7*
  Explain and use the relationship between the sine and cosine of complementary angles.
- *CCSS.Math.Content.HSG.SRT.C.8*
  Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems
- *CCSS.Math.Content.HSF.TF.A.1*
  Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

- *CCSS.Math.Content.HSF.TF.A.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.
- *CCSS.Math.Content.HSF.TF.A.3*
  (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for *x*, π + *x*, and 2π - *x* in terms of their values for *x*, where *x* is any real number.
- *CCSS.Math.Content.HSF.TF.A.4*
  (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions
- *CCSS.Math.Content.HSF.TF.B.5*
  Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*
- *CCSS.Math.Content.HSF.TF.B.6*
  (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.
- *CCSS.Math.Content.HSF.TF.B.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
- *CCSS.Math.Content.HSF.TF.C.8*
  Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.
- *CCSS.Math.Content.HSF.TF.C.9*
  (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 7
- Mid Chapter Quiz 7

Unit 8: Analytic Trigonometry

Essential Questions:

- How are trigonometric functions related to one another?
- How can we solve equations involving trigonometric functions?

Learning Targets:

Students will be able to…:

- Recognize and write the fundamental trigonometric identities
- Use the fundamental trigonometric identities to evaluate trigonometric functions, simplify trigonometric expressions, and rewrite trigonometric expressions

- Verify trigonometric identities
- Use standard algebraic techniques to solve trigonometric equations
- Solve trigonometric equations of quadratic type
- Solve trigonometric equations involving multiple angles
- Use inverse trigonometric equations to solve trigonometric equations
- Use sum and difference formulas to evaluate trigonometric functions, verify identities, and solve trigonometric equations
- Use multiple angle formulas to rewrite and evaluate trigonometric functions
- Use power reducing formulas to rewrite and evaluate trigonometric functions
- Use half angle formulas to rewrite and evaluate trigonometric functions
- Use product to sum and sum to product formulas to rewrite and evaluate trigonometric functions
- Use trigonometric formulas to rewrite real life models

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSF.TF.A.3*
  (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for *x*, π + *x*, and 2π - *x* in terms of their values for *x*, where *x* is any real number.
- *CCSS.Math.Content.HSF.TF.A.4*
  (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions
- *CCSS.Math.Content.HSF.TF.B.5*
  Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*
- *CCSS.Math.Content.HSF.TF.B.6*
  (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.
- *CCSS.Math.Content.HSF.TF.B.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
- *CCSS.Math.Content.HSF.TF.C.8*
  Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.
- *CCSS.Math.Content.HSF.TF.C.9*
  (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 8
- Mid Chapter Quiz 8

Unit 9: Additional Topics in Trigonometry

Essential Questions:

- How can the Law of Sines or Law of Cosines be used to solve triangles?

Learning Targets:

Students will be able to…:

- Use the Law of Sines to solve oblique triangles
- Find the areas of oblique triangles
- Use the Law of Sines to model and solve real life problems
- Use the Law of Cosines to solve oblique triangles
- Use the Law of Cosines to model and solve real life problems
- Use Heron's Area Formula to find the area of a triangle.

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSG.SRT.D.10*
  (+) Prove the Laws of Sines and Cosines and use them to solve problems.
- *CCSS.Math.Content.HSG.SRT.D.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)

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 9
- Mid Chapter Quiz 9

Unit 10: Matrices and Determinants

Essential Questions:

- How can matrices be used to solve a system of equations?
- How can the inverse of a matrix be found?
- What practical applications to matrices have?

Learning Targets:

Students will be able to…:

- Write matrices and identify their orders
- Perform elementary row operations on matrices
- Use matrices and Gaussian elimination to solve systems of linear equations

- Use matrices and Gauss-Jordan elimination to solve systems of linear equations
- Decide whether two matrices are equal
- Add and subtract matrices and multiply matrices by scalars
- Multiply two matrices
- Use matrix operations to model and solve real life problems
- Verify that two matrices are inverses of each other
- Use Gauss-Jordan elimination to find the inverses of matrices
- Use a formula to find the inverse of 2x2 matrices
- Use inverse matrices to solve systems of linear equations
- Find the determinants of 2x2 matrices
- Find minors and cofactors of square matrices
- Find the determinants of square matrices
- Use Cramer's Rule to solve systems of linear equations
- Use determinants to find the areas of triangles
- Use a determinant to test for collinear points and find an equation of a line passing through two points
- Use matrices to encode and decode matrices?

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSN.VM.C.6*
  (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
- *CCSS.Math.Content.HSN.VM.C.7*
  (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.
- *CCSS.Math.Content.HSN.VM.C.8*
  (+) Add, subtract, and multiply matrices of appropriate dimensions.
- *CCSS.Math.Content.HSN.VM.C.9*
  (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
- *CCSS.Math.Content.HSN.VM.C.10*
  (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.
- *CCSS.Math.Content.HSN.VM.C.11*
  (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
- *CCSS.Math.Content.HSN.VM.C.12*
  (+) Work with 2 × 2 matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 10
- Mid Chapter Quiz 10

Unit 11: Conics and Vectors

Essential Questions:

- What is a conic and how do we represent it algebraically?
- How do we sketch the graphs of conics?
- How can vectors be used to describe a location?
- What applications do vectors have to physics?
- What applications to vectors have to trigonometry?

Learning Targets:

Students will be able to…:

- Recognize the four basic conics: circle, ellipse, parabola and hyperbola
- Recognize, graph and write equations of parabolas
- Recognize, graph and write equations of ellipses
- Recognize, graph and write equations of hyperbolas
- Recognize equations of conics that have shifted vertically or horizontally in the plane
- Write and graph equations of conics that have been shifted vertically or horizontally in the plane
- Represent vectors as directed line segments
- Write the component forms of vectors
- Perform basic vector operations and represent the graphically
- Write vectors as linear combinations of unit vectors
- Find the direction angles of vectors
- Use vectors to model and solve real life problems
- Find the dot product of two vectors and use the properties of the dot product
- Find the angle between two vectors and determine whether two vectors are orthogonal
- Write a vector as the sum of two vector components
- Use vectors to find the work done by a force
- Plot complex numbers in the complex plane and find absolute values of complex numbers
- Write trigonometric forms of complex numbers
- Multiply and divide complex numbers written in trigonometric form
- Use DeMoivre's Theorem to find powers of complex numbers
- Find *n*th roots of complex numbers

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSN.VM.A.1*
  (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\boldsymbol{v}$, $|\boldsymbol{v}|$, $||\boldsymbol{v}||$, v).
- *CCSS.Math.Content.HSN.VM.A.2*
  (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
- *CCSS.Math.Content.HSN.VM.A.3*
  (+) Solve problems involving velocity and other quantities that can be represented by vectors

- *CCSS.Math.Content.HSN.VM.B.4.a*
  Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
- *CCSS.Math.Content.HSN.VM.B.4.b*
  Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
- *CCSS.Math.Content.HSN.VM.B.4.c*
  Understand vector subtraction $\boldsymbol{v} - \boldsymbol{w}$ as $\boldsymbol{v} + (-\boldsymbol{w})$, where $-\boldsymbol{w}$ is the additive inverse of $\boldsymbol{w}$, with the same magnitude as $\boldsymbol{w}$ and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.
- *CCSS.Math.Content.HSN.VM.B.5.a*
  Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.
- *CCSS.Math.Content.HSN.VM.B.5.b*
  Compute the magnitude of a scalar multiple $c\boldsymbol{v}$ using $||c\boldsymbol{v}|| = |c|\boldsymbol{v}$. Compute the direction of $c\boldsymbol{v}$ knowing that when $|c|\boldsymbol{v} \neq 0$, the direction of $c\boldsymbol{v}$ is either along $\boldsymbol{v}$ (for $c > 0$) or against $\boldsymbol{v}$ (for $c < 0$)
- *CCSS.Math.Content.HSN.CN.B.4*
  (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.
- *CCSS.Math.Content.HSN.CN.B.5*
  (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation.
- *CCSS.Math.Content.HSN.CN.B.6*
  (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.
- *CCSS.Math.Content.HSG.GPE.A.2*
  Derive the equation of a parabola given a focus and directrix.
- *CCSS.Math.Content.HSG.GPE.A.3*
  (+) 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

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 11
- Mid Chapter Quiz 11

Unit 12: Sequences, Series and Probability

Essential Questions:

- How do arithmetic and geometric sequences differ?
- What is the difference between a sequence and a series?
- How can we find the sum of an arithmetic or geometric sequence or series?
- How can infinite sums be expressed?
- How can the Binomial Theorem be used to expand binomials?
- What is the Fundamental Counting Principle and how can it be used to solve counting problems?
- What scenarios call for the use of a combination and a permutation?

Learning Targets:

Students will be able to…:

- Use sequence notation to write the terms of sequences
- Use factorial notation
- Use summation notation to write sums
- Find the sums of series
- Use sequences and series to model and solve real life problems
- Recognize, write and find the *n*th terms of arithmetic sequences
- Use arithmetic sequences to model and solve real life problems
- Recognize, write and find the *n*th terms of geometric sequences
- Find the sum of a finite geometric sequence
- Find the sum of an infinite geometric series
- Use geometric sequences to model and solve real life problems
- Use mathematical induction to prove statements involving a positive integer
- Use pattern recognition and mathematical induction to write the *n*th term of a sequence
- Find the sums of powers of integers
- Find finite differences of sequences
- Use the Binomial Theorem to calculate binomial coefficients
- Use Pascal's Triangle to calculate binomial coefficients
- Use binomial coefficients to write binomial expansions
- Solve simple counting problems
- Use the Fundamental Counting Principle to solve counting problems
- Use permutations and combinations to solve counting problems
- Find the probabilities of events
- Find the probabilities of mutually exclusive events and independent events
- Find the probability of the complement of an event

Academic Standards Addressed (CCSS):

- *CCSS.Math.Content.HSA.SSE.B.4*
  Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems.

- *CCSS.Math.Content.HSS.CP.B.6*
  Find the conditional probability of *A* given *B* as the fraction of *B*'s outcomes that also belong to *A*, and interpret the answer in terms of the model.
- *CCSS.Math.Content.HSS.CP.B.7*
  Apply the Addition Rule, P(A or B) = P(A) + P(B) - P(A and B), and interpret the answer in terms of the model.
- *CCSS.Math.Content.HSS.CP.B.8*
  (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.
- *CCSS.Math.Content.HSS.CP.B.9*
  (+) Use permutations and combinations to compute probabilities of compound events and solve problems.
- *CCSS.Math.Content.HSS.CP.A.5*
  Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
- *CCSS.Math.Content.HSS.CP.A.4*
  Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.
- *CCSS.Math.Content.HSS.CP.A.1*
  Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").
- *CCSS.Math.Content.HSS.CP.A.2*
  Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
- *CCSS.Math.Content.HSS.CP.A.3*
  Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P*(*B*), and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of *A*, and the conditional probability of *B* given *A* is the same as the probability of *B*
- *CCSS.Math.Content.HSA.APR.C.5*
  (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of *x* and *y* for a positive integer *n*, where *x* and *y* are any numbers, with coefficients determined for example by Pascal's Triangle

Common Assessments:

- Daily Quizzes
- Daily Homework
- Unit Exam 12
- Mid Chapter Quiz 12