High School – Complex Number System

Essential Questions:

1. Why do we use numbers, what are their properties, and how does our number system function?
2. Why do we use estimation and when is it appropriate?
3. What makes a strategy effective and efficient and the solution reasonable?
4. How do numbers relate and compare to one another?

Essential Vocabulary - conjugate, complex number, moduli, complex plane, rectangular form, polar form, conjugation, quadratic equations, real coefficients, complex solutions, polynomial identities, Fundamental Theorem of Algebra

HS.N-CN.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.

High School Enduring Understandings Alg 2/ Trig

Students will know…	***Students will understand…***	***Students will be able to…***
1. The definition of a complex number and *i*.	1. That there is a meaning of *i*. 2. That all whole number powers of *i* can be simplified to *i*,-1, -*i*, and 1 . 3. That all numbers can be written in complex form.	1. Identify *a* and *b* in a complex number and know that *a* is the real part of the number and *bi* is the pure imaginary part of the complex number . 2. Simplify i^n, where n is an integer.

HS.N-CN.2: Use the relation $i^2 = –1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

High School Enduring Understandings Alg 2/ Trig

Students will know…	***Students will understand…***	***Students will be able to…***
1. The definition of commutative, associative and distributive properties.	1. That the properties of the real number system, commutative, associative and distributive properties, also apply to complex numbers.	1. Add, subtract and multiply complex numbers.

HS.N-CN.3: (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. The definition of conjugate, complex number, moduli, and quotient.	1. That a complex number has a conjugate and that the conjugate can be used to find the moduli and the quotient of a rational expressions that has a complex number in the denominator.	1. Find complex number conjugates. 2. Use conjugates to find moduli and quotients of complex numbers.

HS.N-CN.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.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. That complex numbers can be written in rectangular and polar form.	1. That rectangular form and polar form represent the same complex number. 2. The relationship between the rectangular and polar form of a complex number.	1. Represent a complex number in rectangular and polar form. 2. Graph a complex number on the complex plane and polar plane. 3. Explain the relationship between the rectangular and polar form of a complex number.

HS.N-CN.5: (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. *For example,* $\left(-1+\sqrt{3}i\right)^3 = 8$ *because* $\left(-1+\sqrt{3}i\right)$ *has modulus 2 and argument 120°.*

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. conjugation, addition, subtraction, multiplication of complex numbers, complex plane, properties, computation	1. The relationship between the graph of a complex number and the operations of addition, subtraction, and multiplication; and the conjugation of complex numbers on the complex plane.	1. Graph complex numbers on the complex plane and then add, subtract, and multiply complex numbers geometrically using the complex plane.

HS.N-CN.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.

High School Enduring Understandings Geometry, Alg 2 / Trig, Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. distance, complex plane, midpoint, average, modulus, endpoints	1. that finding the distance and midpoint between complex numbers in the complex plane is analogous to finding the distance and midpoint between rectangular coordinates on the Cartesian plane.	1. Calculate the distance between numbers in the complex plane using the modulus of the difference. 2. Calculate the midpoint of a segment as the average of the numbers of its endpoints.

HS.N-CN.7: Solve quadratic equations with real coefficients that have complex solutions.		
High School Enduring Understandings Alg 2 / Trig		
Students will know…	***Students will understand…***	***Students will be able to…***
1. The quadratic formula.	1. That when using the quadratic formula you can arrive at either real or complex solutions and the value of the discriminant determines the type of solution.	1. Solve a quadratic equation with real coefficients using the quadratic formula which results in complex solutions.
HS.N-CN.8: (+) Extend polynomial identities to the complex numbers. *For example, rewrite* $x^2 + 4$ *as* $(x + 2i)(x – 2i)$.		
High School Enduring Understandings Alg 2 / Trig		
Students will know…	***Students will understand…***	***Students will be able to…***
1. polynomial identities, complex numbers	1. That polynomial identities extend complex numbers.	1. Apply their knowledge of polynomial identities to complex numbers.
HS.N-CN.9: (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.		
High School Enduring Understandings Alg 1 & Alg 2 / Trig		
Students will know…	***Students will understand…***	***Students will be able to…***
1. Fundamental Theorem of Algebra, quadratic polynomials	1. The relationship between the Fundamental Theorem of Algebra and quadratic polynomials.	1. Apply the Fundamental Theorem of Algebra to show that it is true for quadratic polynomials.

High School - Quantities

Essential Questions:

1. Why do we use numbers, what are their properties, and how does our number system function?
2. Why do we use estimation and when is it appropriate?
3. What makes a strategy effective and efficient and the solution reasonable?
4. How do numbers relate and compare to one another?

HS.N-Q.1: Use units as a way to understand problems from a variety of contexts (e.g., science, history, and culture), including those of Montana American Indians, and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

High School Enduring Understandings Alg 1

Students will know…	*Students will understand…*	*Students will be able to…*
1. That you need consistent units within a problem.	1. The importance of consistent units in understanding problems, solving multi-step problems, using formulas, and in scaling axes when graphing.	1. Convert to consistent units within a problem.

HS.N-Q.2: Define appropriate quantities for the purpose of descriptive modeling.

High School Enduring Understandings Geometry

Students will know…	*Students will understand…*	*Students will be able to…*
1. appropriate units, scaling	1. that in descriptive modeling quantities can be scaled for ease of manipulation.	1. take units that are too large to work with and scale them down to a model appropriate for the classroom or units that are too small to work with and scale them up.

HS.N-Q.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

High School Enduring Understandings All Courses

Students will know…	*Students will understand…*	*Students will be able to…*
1. what is the least accurate measurement	1. that the solution is only as accurate as the least accurate measurement 2. that measurement tools have limitations	1. report solutions with the appropriate accuracy 2. choose the appropriate measurement

High School – Real Number System

Essential Questions:

1. Why do we use numbers, what are their properties, and how does our number system function?
2. Why do we use estimation and when is it appropriate?
3. What makes a strategy effective and efficient and the solution reasonable?
4. How do numbers relate and compare to one another?

Essential Vocabulary – rational exponent, exponent, base, rational exponent form, radical form

HS.N-RN.1: Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.*

High School Enduring Understandings Alg 2 / Trig

Students will know…	***Students will understand…***	***Students will be able to…***
1. How to recognize a rational exponent.	1. that the rules of exponents apply to integer and rational number exponents.	1. apply the rules of integer exponents to expressions with rational exponents

HS.N-RN.2: Rewrite expressions involving radicals and rational exponents using the properties of exponents.

High School Enduring Understandings Alg 2 / Trig

Students will know…	***Students will understand…***	***Students will be able to…***
1. how to identify rational form and radical form	1. That the choice of form, rational exponent form or radical form, is sometimes dependent on the operation required.	1. Convert between rational exponent form and radical form.

HS.N-RN.3: Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

High School Enduring Understandings Alg 1 & Alg 2 / Trig

Students will know…	***Students will understand…***	***Students will be able to…***
1. the definition of a rational and irrational number, and the property of closure.	1. that the concept of closure can be applied to rational and irrational numbers.	1. perform operations with rational and/or irrational numbers

High School – Vectored and Matrix Quantities

Essential Questions:

1. Why do we use numbers, what are their properties, and how does our number system function?
2. Why do we use estimation and when is it appropriate?
3. What makes a strategy effective and efficient and the solution reasonable?
4. How do numbers relate and compare to one another?

Essential Vocabulary – vector, vector quantities, magnitude, direction, directed line segments, components of a vector, terminal point, initial point, velocity, vector representation of quantities, vector subtraction, parallelogram rule, scalar, scalar multiplication, matrices, matrix multiplication, square matrices, commutative operation, associative properties, distributive properties, zero matrix, identity matrix, determinant, multiplicative inverse of a matrix, transformations of vectors, determinant

HS.N-VM.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).

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. The definition of a vector, a vector quantity, magnitude, direction, and directed line segments.	2. That vectors can be represented graphically on a plane and that a vector can be described by its magnitude and direction.	1. use appropriate symbolism for vectors and represent vectors graphically

HS.N-VM.2: (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. components of a vector, terminal point, initial point	1. that the coordinates of a vector in vector component form are the horizontal and vertical components of the vector	1. express a vector in vector component form

HS.N-VM.3: (+) Solve problems from a variety of contexts (e.g., science, history, and culture), including those of Montana American Indians, involving velocity and other quantities that can be represented by vectors.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. velocity, vectors, vector representation of quantities	1. the importance of determining when it is appropriate to use vectors.	1. Represent problems from a variety of contexts as a vector or vectors and solve for the desired solution.

HS.N-VM.4: (+) Add and subtract vectors.

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.

b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

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 magnitudes 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.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. vector, parallelogram rule, magnitude, direction, vector subtraction, additive inverse, vector components	1. Various methods for adding and subtracting vectors, algebraically and graphically.	1. Find the magnitude and direction of the sum or difference of vectors.

HS.N-VM.5: (+) Multiply a vector by a scalar.

a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.

b. Compute the magnitude of a scalar multiple $c\boldsymbol{v}$ using $\|c\boldsymbol{v}\| = |c|v$. 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 $c < 0$).

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. vector, scalar, scalar multiplication, magnitude, direction	1. that multiplying by a nonzero scalar will change the magnitude and possibly the direction of the vector.	1. Multiply a vector by a scalar.

HS.N-VM.6: (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

High School Enduring Understandings Stats

Students will know…	***Students will understand…***	***Students will be able to…***
1. The definition of a matrix	1. That matrices can be used to represent and manipulate data.	1. represent and manipulate data with a matrix

HS.N-VM.7: (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. the definition of a matrix and scalars	1. That multiplying a matrix by a scalar will multiply each element by that scalar.	1. Multiply a matrix by a scalar.

HS.N-VM.8: (+) Add, subtract, and multiply matrices of appropriate dimensions.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. The definition a matrix.	1. That appropriate dimensions are necessary to add, subtract, and multiply matrices.	1. add, subtract, and multiply matrices

HS.N-VM.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.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. the definition of matrix multiplication, square matrices, commutative operation, associative properties, and distributive properties.	1. that there are associative and distributive properties for square matrices, but the commutative property is not necessarily true for square matrices.	1. perform matrix multiplication.

HS.N-VM.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.

High School Enduring Understandings Alg 3

Students will know…	***Students will understand…***	***Students will be able to…***
1. the definition of zero matrix, identity matrix, determinant, and multiplicative inverse of a matrix	1. that the zero and identity matrices play an analogous role in matrix addition and multiplication to 0 and 1 in real numbers. 2. That a nonzero determinant of a square matrix guarantees a multiplicative inverse.	1. Add and multiply with the zero matrix and identity matrix. 2. Find the determinant of a square matrix.

HS.N-VM.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.

High School Enduring Understandings Analysis		
Students will know… 1. the definition of vector, matrix, and transformations	***Students will understand…*** 1. That a matrix of suitable dimensions is need to multiply by a vector (column matrix) and produce another vector. 2. that transformations of vectors relates to matrices.	***Students will be able to…*** 1. multiply a vector by a suitable dimension matrix.
HS.N-VM.12: (+) Work with 2 x 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.		
High School Enduring Understandings Geometry		
Students will know… 1. the definition of matrices, transformation, plane, absolute value, determinant, and area	***Students will understand…*** 1. that the area of a geometric figure can be determined by finding the absolute value of the determinant of the matrix formed by the coordinates of the vertices.	***Students will be able to…*** 1. determine the absolute value of the determinant by finding the area.