

Higher Mathematics Course — Number and Quantity

Adopted 2010

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The Real Number System

- A. Extend the properties of exponents to rational exponents. **HSN.RN.A**
 - 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. **N.RN.1**
 - 2. Rewrite expressions involving radicals and rational exponents using the properties of exponents. **N.RN.2**
- B. Use properties of rational and irrational numbers. **HSN.RN.B**
 - 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. **N.RN.3**

Quantities

- A. Reason quantitatively and use units to solve problems. **HSN.Q.A**
 - 1. Use units as a way to understand problems 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. **N.Q.1**
 - 2. Define appropriate quantities for the purpose of descriptive modeling. **N.Q.2**
 - 3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **N.Q.3**

The Complex Number System

- A. Perform arithmetic operations with complex numbers. **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. **N.CN.1**
 - 2. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. **N.CN.2**
 - 3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. **N.CN.3**
- B. Represent complex numbers and their operations on the complex plane. **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. **N.CN.4**
 - 5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. **N.CN.5**
 - 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. **N.CN.6**
- C. Use complex numbers in polynomial identities and equations. **HSN.CN.C**
 - 7. Solve quadratic equations with real coefficients that have complex solutions. **N.CN.7**
 - 8. (+) Extend polynomial identities to the complex numbers. **N.CN.8**
 - 9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials. **N.CN.9**

Vector and Matrix Quantities

- A. Represent and model with vector quantities. [HSN.VM.A](#)
- (+) 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., v , $|v|$, $\|v\|$, v). [N.VM.1](#)
 - (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. [N.VM.2](#)
 - (+) Solve problems involving velocity and other quantities that can be represented by vectors. [N.VM.3](#)
- B. Perform operations on vectors. [HSN.VM.B](#)
- (+) Add and subtract vectors. [N.VM.4](#)
 - 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. [N.VM.4.A](#)
 - Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. [N.VM.4.B](#)
 - Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w , with the same magnitude as 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. [N.VM.4.C](#)
 - (+) Multiply a vector by a scalar. [N.VM.5](#)
 - Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c\langle v_x, v_y \rangle = \langle cv_x, cv_y \rangle$. [N.VM.5.A](#)
 - Compute the magnitude of a scalar multiple cv using $\|cv\| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$). [N.VM.5.B](#)
- C. Perform operations on matrices and use matrices in applications. [HSN.VM.C](#)
- (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. [N.VM.6](#)
 - (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. [N.VM.7](#)
 - (+) Add, subtract, and multiply matrices of appropriate dimensions. [N.VM.8](#)
 - (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. [N.VM.9](#)
 - (+) 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. [N.VM.10](#)

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. [N.VM.11](#)
12. (+) Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area. [N.VM.12](#)