North Carolina Mathematics

# 4th Level : Grades 9, 10, 11, 12

Adopted 2019

## Standards for Mathematical Practice

1. **Make sense of problems and persevere in solving them.** MP.1
2. **Reason abstractly and quantitatively.** MP.2
3. **Construct viable arguments and critique the reasoning of others.** MP.3
4. **Model with mathematics.** MP.4
5. **Use appropriate tools strategically.** MP.5
6. **Attend to precision.** MP.6
7. **Look for and make use of structure.** MP.7
8. **Look for and express regularity in repeated reasoning.** MP.8
9. **Use strategies and procedures flexibly.** MP.9
10. **Reflect on mistakes and misconceptions.** MP.10

**Discrete Mathematics for Computer Science**

## Number and Quantity

1. Apply operations with matrices and vectors. DCS.N.1
    1. Implement procedures of addition, subtraction, multiplication, and scalar multiplication on matrices. DCS.N.1.1
    2. Implement procedures of addition, subtraction, and scalar multiplication on vectors. DCS.N.1.2
    3. Implement procedures to find the inverse of a matrix. DCS.N.1.3
2. Understand matrices to solve problems. DCS.N.2
    1. Organize data into matrices to solve problems. DCS.N.2.1
    2. Interpret solutions found using matrix operations including Leslie Models and Markov Chains, in context. DCS.N.2.2
    3. Represent a system of equations as a matrix equation. DCS.N.2.3
    4. Use inverse matrices to solve a system of equations with technology. DCS.N.2.4
3. Understand set theory to solve problems. DCS.N.3
    1. Recognize sets, subsets, and proper subsets. DCS.N.3.1
    2. Implement set operations to find unions, intersections, complements and set differences with multiple sets. DCS.N.3.2
    3. Represent properties and relationships among sets using Venn diagrams. DCS.N.3.3
    4. Interpret Venn diagrams to solve problems. DCS.N.3.4
4. Understand statements related to number theory and set theory. DCS.N.4
    1. Use the Euclidean Algorithm to determine greatest common factor and least common multiple. DCS.N.4.1
    2. Use the Fundamental Theorem of Arithmetic to solve problems. DCS.N.4.2
    3. Conclude that sets are equal using the properties of set operations. DCS.N.4.3
    4. Explain theorems related to greatest common factor, least common multiple, even numbers, odd numbers, prime numbers, and composite numbers. DCS.N.4.4

### Functions

1. Apply recursively-defined relationships to solve problems. DCS.F.1
    1. Implement procedures to find the nth term in an arithmetic or geometric sequence using spreadsheets. DCS.F.1.1
    2. Represent the sum of a sequence using sigma notation. DCS.F.1.2
    3. Implement procedures to find the sum of a finite sequence. DCS.F.1.3
    4. Implement procedures to find the sum of an infinite sequence and determine if the series converges or diverges. DCS.F.1.4
    5. Interpret the solutions to arithmetic and geometric sequences and series problems, in context. DCS.F.1.5

### Statistics and Probability

1. Apply combinatorics concepts to solve problems. DCS.SP.1
    1. Implement the Fundamental Counting Principle to solve problems. DCS.SP.1.1
    2. Implement procedures to calculate a permutation or combination. DCS.SP.1.2

### Graph Theory

1. Understand graph theory to model relationships and solve problems. DCS.GT.1
    1. Represent real world situations with a vertex-edge graph, adjacency matrix, and vertex-edge table. DCS.GT.1.1
    2. Test graphs and digraphs for Euler paths, Euler circuits, Hamiltonian paths, or Hamiltonian circuits. DCS.GT.1.2
    3. Interpret a complete digraph to determine rank. DCS.GT.1.3
2. Apply graph theory to solve problems. DCS.GT.2
    1. Implement critical path analysis algorithms to determine the minimum project time. DCS.GT.2.1
    2. Implement the brute force method, the nearest-neighbor algorithm, and the cheapest-link algorithm to find solutions to a Traveling Salesperson Problem. DCS.GT.2.2
    3. Implement vertex-coloring techniques to solve problems. DCS.GT.2.3
    4. Implement Kruskal and Prim's algorithms to determine the weight of the minimum spanning tree of a connected graph. DCS.GT.2.4

**Logic**

1. Evaluate mathematical logic to model and solve problems. DCS.L.1
    1. Construct truth tables that encode the truth and falsity of two or more statements. DCS.L.1.1
    2. Critique logic arguments (e.g., determine if a statement is valid or whether an argument is a tautology or contradiction). DCS.L.1.2
    3. Check 1s and 0s to determine whether a statement is true or false using Boolean logic circuits. DCS.L.1.3
    4. Judge whether two statements are logically equivalent using truth tables. DCS.L.1.4

**North Carolina Math 4**

**Number and Quantity**

1. Apply properties and operations with complex numbers. NC.M4.N.1
    1. Execute procedures to add and subtract complex numbers. NC.M4.N.1.1
    2. Execute procedures to multiply complex numbers. NC.M4.N.1.2
2. Apply properties and operations with matrices and vectors. NC.M4.N.2
    1. Execute procedures of addition, subtraction, multiplication, and scalar multiplication on matrices. NC.M4.N.2.1
    2. Execute procedures of addition, subtraction, and scalar multiplication on vectors. NC.M4.N.2.2

**Algebra and Functions**

1. Apply properties of function composition to build new functions from existing functions. NC.M4.AF.1
    1. Execute algebraic procedures to compose two functions. NC.M4.AF.1.1
    2. Execute a procedure to determine the value of a composite function at a given value when the functions are in algebraic, graphical, or tabular representations. NC.M4.AF.1.2
2. Apply properties of trigonometry to solve problems. NC.M4.AF.2
    1. Translate trigonometric expressions using the reciprocal and Pythagorean identities. NC.M4.AF.2.1
    2. Implement the Law of Sines and the Law of Cosines to solve problems. NC.M4.AF.2.2
    3. Interpret key features (amplitude, period, phase shift, vertical shifts, midline, domain, range) of models using sine and cosine functions in terms of a context. NC.M4.AF.2.3
3. Apply the properties and key features of logarithmic functions. NC.M4.AF.3
    1. Execute properties of logarithms to rewrite expressions and solve equations algebraically. NC.M4.AF.3.1
    2. Implement properties of logarithms to solve equations in contextual situations. NC.M4.AF.3.2
    3. Interpret key features of a logarithmic function using multiple representations. NC.M4.AF.3.3
4. Understand the properties and key features of piecewise functions. NC.M4.AF.4
    1. Translate between algebraic and graphical representations of piecewise functions (linear, exponential, quadratic, polynomial, square root). NC.M4.AF.4.1
    2. Construct piecewise functions to model a contextual situation. NC.M4.AF.4.2
5. Understand how to model functions with regression. NC.M4.AF.5
    1. Construct regression models of linear, quadratic, exponential, logarithmic, & sinusoidal functions of bivariate data using technology to model data and solve problems. NC.M4.AF.5.1
    2. Compare residuals and residual plots of non-linear models to assess the goodness-of-fit of the model. NC.M4.AF.5.2

**Statistics and Probability**

1. Create statistical investigations to make sense of real world phenomenon NC.M4.SP.1
    1. Construct statistical questions to guide explorations of data in context. NC.M4.SP.1.1
    2. Design sample surveys and comparative experiments using sampling methods to collect and analyze data to answer a statistical question. NC.M4.SP.1.2
    3. Organize large datasets of real world contexts (i.e. datasets that include 3 or more measures and have sample sizes >200) using technology (e.g., spreadsheets, dynamic data analysis tools) to determine: types of variables in the data set, possible outcomes for each variable, statistical questions that could be asked of the data, and types of numerical and graphical summaries could be used to make sense of the data. NC.M4.SP.1.3
    4. Interpret non-standard data visualizations from the media or scientific papers to make sense of real world phenomenon. NC.M4.SP.1.4
2. Apply informal and formal statistical inference to make sense of, and make decisions in, meaningful real world contexts. NC.M4.SP.2
    1. Design a simulation to make a sampling distribution that can be used in making informal statistical inferences. NC.M4.SP.2.1
    2. Construct confidence intervals of population proportions in the context of the data. NC.M4.SP.2.2
    3. Implement a one proportion z-test to determine if an observed proportion is significantly different from a hypothesized proportion. NC.M4.SP.2.3
3. Apply probability distributions in making decisions in uncertainty. NC.M4.SP.3
    1. Implement discrete probability distributions to model random phenomenon and make decisions (e.g., expected value of playing a game, etc). NC.M4.SP.3.1
    2. Implement the binomial distribution to model situations and make decisions. NC.M4.SP.3.2
    3. Recognize from simulations of sampling distributions of sample means and proportions that a normal distribution can be used as an approximate model in certain situations. NC.M4.SP.3.3
    4. Implement the normal distribution as a probability distribution to determine the likelihood of events occurring. NC.M4.SP.3.4

**Precalculus**

## Number and Quantity

1. Apply properties of complex numbers and the complex number system. PC.N.1
    1. Execute the sum and difference algorithms to combine complex numbers. PC.N.1.1
    2. Execute the multiplication algorithm with complex numbers. PC.N.1.2
2. Apply properties and operations with matrices. PC.N.2
    1. Execute the sum and difference algorithms to combine matrices of appropriate dimensions. PC.N.2.1
    2. Execute associative and distributive properties to matrices. PC.N.2.2
    3. Execute commutative property to add matrices. PC.N.2.3
    4. Execute properties of matrices to multiply a matrix by a scalar. PC.N.2.4
    5. Execute the multiplication algorithm with matrices. PC.N.2.5
3. Understand properties and operations with vectors. PC.N.3
    1. Represent a vector indicating magnitude and direction. PC.N.3.1
    2. Execute sum and difference algorithms to combine vectors. PC.N.3.2

## Algebra

1. Apply properties of solving inequalities that include rational and polynomial expressions in one variable. PC.A.1
    1. Implement algebraic (sign analysis) methods to solve rational and polynomial inequalities. PC.A.1.1
    2. Implement graphical methods to solve rational and polynomial inequalities. PC.A.1.2
2. Apply properties of solving equations involving exponential, logarithmic, and trigonometric functions. PC.A.2
    1. Use properties of logarithms to rewrite expressions. PC.A.2.1
    2. Implement properties of exponentials and logarithms to solve equations. PC.A.2.2
    3. Implement properties of trigonometric functions to solve equations including<ul><li>inverse trigonometric functions,</li><li>double angle formulas, and</li><li>Pythagorean identities.</li></ul> PC.A.2.3
    4. Implement algebraic techniques to rewrite parametric equations in cartesian form by eliminating the parameter. PC.A.2.4

**Functions**

1. Understand key features of sine, cosine, tangent, cotangent, secant and cosecant functions. PC.F.1
    1. Interpret algebraic and graphical representations to determine key features of transformed sine and cosine functions. Key features include: amplitude, domain, midline, phase shift, frequency, period, intervals where the function is increasing, decreasing, positive or negative, relative maximums and minimums. PC.F.1.1
    2. Interpret algebraic and graphical representations to determine key features of tangent, cotangent, secant, and cosecant. Key features include: domain, frequency, period, intervals where the function is increasing, decreasing, positive or negative, relative maximums and minimums, and asymptotes. PC.F.1.2
    3. Integrate information to build trigonometric functions with specified amplitude, frequency, period, phase shift, or midline with or without context. PC.F.1.3
    4. Implement graphical and algebraic methods to solve trigonometric equations and inequalities in context with support from technology. PC.F.1.4
2. Apply properties of a unit circle with center (0,0) to determine the values of sine, cosine, tangent, cotangent, secant, and cosecant. PC.F.2
    1. Use a unit circle to find values of sine, cosine, and tangent for angles in terms of reference angles. PC.F.2.1
    2. Explain the relationship between the symmetry of a unit circle and the periodicity of trigonometric functions. PC.F.2.2
3. Apply properties of trigonometry to solve problems involving all types of triangles. PC.F.3
    1. Implement a strategy to solve equations using inverse trigonometric functions. PC.F.3.1
    2. Implement the Law of Sines and the Law of Cosines to solve problems. PC.F.3.2
    3. Implement the Pythagorean identity to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle. PC.F.3.3
4. Understand the relationship of algebraic and graphical representations of exponential, logarithmic, rational, power functions, and conic sections to their key features. PC.F.4
    1. Interpret algebraic and graphical representations to determine key features of exponential functions. Key features include: domain, range, intercepts, intervals where the function is increasing, decreasing, positive or negative, concavity, end behavior, limits, and asymptotes. PC.F.4.1
    2. Integrate information to build exponential functions to model phenomena involving growth or decay. PC.F.4.2
    3. Interpret algebraic and graphical representations to determine key features of logarithmic functions. Key features include: domain, range, intercepts, intervals where the function is increasing, decreasing, positive or negative, concavity, end behavior, continuity, limits, and asymptotes. PC.F.4.3

4. Implement graphical and algebraic methods to solve exponential and logarithmic equations in context with support from technology. PC.F.4.4
5. Interpret algebraic and graphical representations to determine key features of rational functions. Key features include: domain, range, intercepts, intervals where the function is increasing, decreasing, positive or negative, concavity, end behavior, continuity, limits, and asymptotes. PC.F.4.5
6. Implement graphical and algebraic methods to solve optimization problems given rational and polynomial functions in context with support from technology. PC.F.4.6
7. Construct graphs of transformations of power, exponential, and logarithmic functions showing key features. PC.F.4.7
8. Identify the conic section (ellipse, hyperbola, parabola) from its algebraic representation in standard form. PC.F.4.8
9. Interpret algebraic and graphical representations to determine key features of conic sections (ellipse: center, length of the major and minor axes; hyperbola: vertices, transverse axis; parabola: vertex, axis of symmetry). PC.F.4.9

5. Apply properties of function composition to build new functions from existing functions. PC.F.5
    1. Implement algebraic procedures to compose functions. PC.F.5.1
    2. Execute a procedure to determine the value of a composite function at a given value using algebraic, graphical, and tabular representations. PC.F.5.2
    3. Implement algebraic methods to find the domain of a composite function. PC.F.5.3
    4. Organize information to build models involving function composition. PC.F.5.4
    5. Deconstruct a composite function into two functions. PC.F.5.5
    6. Implement algebraic and graphical methods to find an inverse function of an existing function, restricting domains if necessary. PC.F.5.6
    7. Use composition to determine if one function is the inverse of another function. PC.F.5.7
6. Apply mathematical reasoning to build recursive functions to model and solve problems. PC.F.6
    1. Use algebraic representations to build recursive functions. PC.F.6.1
    2. Construct a recursive function for a sequence represented numerically. PC.F.6.2
7. Apply mathematical reasoning to build parametric functions and solve problems. PC.F.7
    1. Implement algebraic methods to write parametric equations in context. PC.F.7.1
    2. Implement technology to solve contextual problems involving parametric equations. PC.F.7.2