West Virginia math4life

Content and Timeline for Mathematics

Mathematics II

West Virginia DEPARTMENT OF EDUCATION

Mathematics II

The West Virginia College- and Career-Readiness Standards for mathematics emphasize key content, skills, and mathematical habits of mind at each grade level. The focus of instruction is placed on course standards; instruction should integrate content standards and mathematical habits of mind. Instruction should be attentive to learning across course domains and link major topics within domains. Instruction should develop conceptual understanding, procedural skill and fluency, and application.

Students in Mathematics II focus on the need to extend the set of rational numbers, introducing real and complex numbers so that all quadratic equations can be solved. Students explore the link between probability and data through conditional probability and counting methods, including their use in making and evaluating decisions. The study of similarity leads students in Mathematics II to an understanding of right triangle trigonometry and connections to quadratics through Pythagorean relationships. Students explore circles, with their quadratic algebraic representations.

The following table highlights the content at the cluster level for Mathematics II standards. The bulk of instructional time should be given to the clusters and the standards within them. Standards should not be neglected; to do so would result in gaps in students' learning, including skills and understandings they may need in later grades. Instruction should reinforce standards within the clusters by including problems and activities that support natural connections between clusters. **Teachers and administrators alike should note that the standards are not topics to be checked off after being covered in isolated units of instruction;** rather, they provide content to be developed throughout the school year through rich instructional experiences presented in a coherent manner.

Connections in the Integrated Pathway

In Mathematics I, students extend their previous work with linear and exponential expressions, equations, and systems of equations and inequalities to quadratic relationships. A parallel extension occurs from linear and exponential functions to quadratic functions: students begin to analyze functions in terms of transformations. Building on their work with transformations, students produce increasingly formal arguments about geometric relationships, particularly around notions of similarity.

In Mathematics II, students extend the laws of exponents to rational exponents and explore distinctions between rational and irrational numbers by considering their decimal representations. Students learn that when quadratic equations do not have real solutions, the number system can be extended so that solutions exist, analogous to the way in which extending whole numbers to negative numbers allows $x + 1 = 0$ to have a solution. Students explore relationships between number systems: whole numbers, integers, rational numbers, real numbers, and complex numbers. The guiding principle is that equations with no solutions in one number system may have solutions in a larger number system.

Students consider quadratic functions, comparing the key characteristics of quadratic functions to those of linear and exponential functions. They select from these functions to model phenomena. Students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions. In particular, they identify the real solutions of a quadratic equation as the zeros of a

related quadratic function. Students also learn that when quadratic equations do not have real solutions, the graph of the related quadratic function does not cross the horizontal axis. Additionally, students expand their experience with functions to include more specialized functions—absolute value, step, and other piecewise-defined functions.

Students in Mathematics II focus on the structure of expressions, writing equivalent expressions to clarify and reveal aspects of the quantities represented. Students create and solve equations, inequalities, and systems of equations involving exponential and quadratic expressions.

Building on probability concepts introduced in the middle grades, students use the language of set theory to expand their ability to compute and interpret theoretical and experimental probabilities for compound events, attending to mutually exclusive events, independent events, and conditional probability. Students use probability to make informed decisions, and they should make use of geometric probability models whenever possible.

Students apply their earlier experience with dilations and proportional reasoning to build a formal understanding of similarity. They identify criteria for similarity of triangles, use similarity to solve problems, and apply similarity in right triangles to understand right-triangle trigonometry, with particular attention to special right triangles and the Pythagorean Theorem. In Mathematics II, students develop facility with geometric proof. They use what they know about congruence and similarity to prove theorems involving lines, angles, triangles, and other polygons. They also explore a variety of formats for writing proofs.

In Mathematics II, students prove basic theorems about circles, chords, secants, tangents, and angle measures. In the Cartesian coordinate system, students use the distance formula to write the equation of a circle when given the radius and the coordinates of its center, and the equation of a parabola with a vertical axis when given an equation of its horizontal directrix and the coordinates of its focus. Given an equation of a circle, students draw the graph in the coordinate plane and apply techniques for solving quadratic equations to determine intersections between lines and circles, between lines and parabolas, and between two circles. Students develop informal arguments to justify common formulas for circumference, area, and volume of geometric objects, especially those related to circles.

Mathematics II	West Virginia College- and Career-Readiness Standards
Extending the Number System	
Clusters	
• Extend the properties of exponents to rational exponents. • Use properties of rational and irrational numbers. • Perform arithmetic operations with complex numbers. • Perform arithmetic operations on polynomials.	• M.2HS.1-2 • M.2HS.3 • M.2HS.4-5 • M.2HS.6
Quadratic Functions and Modeling	
Clusters	
• Interpret functions that arise in applications in terms of a context. • Analyze functions using different representations. • Build a function that models a relationship between two quantities. • Build new functions from existing functions. • Construct and compare linear, quadratic, and exponential models and solve problems.	• M.2HS.7-9 • M.2HS.10-12 • M.2HS.13 • M.2HS.14-15 • M.2HS.16
Expressions and Equations	
Clusters	
• Interpret the structure of expressions. • Write expressions in equivalent forms to solve problems. • Create equations that describe numbers or relationships. • Solve equations and inequalities in one variable. • Use complex numbers in polynomial identities and equations. • Solve systems of equations.	• M.2HS.17-18 • M.2HS.19 • M.2HS.20-22 • M.2HS.23 • M.2HS.24-26 • M.2HS.27
Applications of Probability	
Clusters	
• Understand independence and conditional probability and use them to interpret data. • Use the rules of probability to compute probabilities of compound events in a uniform probability model. • Use probability to evaluate outcomes of decisions.	• M.2HS.28-32 • M.2HS.33-36 • M.2HS.37-38

Similarity, Right Triangle Trigonometry, and Proof	
Clusters	
• Understand similarity in terms of similarity transformations. • Prove geometric theorems. • Prove theorems involving similarity. • Use coordinates to prove simple geometric theorems algebraically. • Define trigonometric ratios and solve problems involving right triangles. • Prove and apply trigonometric identities.	• M.2HS.39-41 • M.2HS.42-44 • M.2HS.45-46 • M.2HS.47 • M.2HS.48-50 • M.2HS. 51
Circles With and Without Coordinates	
Clusters	
• Understand and apply theorems about circles. • Find arc lengths and areas of sectors of circles. • Translate between the geometric description and the equation for a conic section. • Use coordinates to prove simple geometric theorems algebraically. • Explain volume formulas and use them to solve problems.	• M.2HS.52-55 • M.2HS.56 • M.2HS.57-58 • M.2HS.59 • M.2HS.60-61

Explanations

- **Domains** are broad components that make up a content area. Domains in mathematics vary by grade-level and by course. For example, the six domains for mathematics of Mathematics II are Extending the Number System; Quadratic Functions and Modeling; Expressions and Equations; Applications of Probability; Similarity, Right Triangle Trigonometry, and Proof; and Circles With and Without Coordinates.
- **Clusters** are groups of standards that define the expectations students must demonstrate to be college- and career-ready.
- **Standards** are expectations for what students should know, understand and be able to do; standards represent educational goals.

Note of caution: Neglecting material will leave gaps in students' skills and understandings and will leave students unprepared for the challenges they face in later grades.

Mathematics II Content Plan

Teachers must provide students the opportunity to master each of the course content standards. **It is important to understand that neglecting grade-level or course content standards will leave gaps in students' skills and understandings and will leave students unprepared for the challenges they face in this and later courses**. Any content plan must demonstrate a means by which students can be provided the opportunity to address all course content standards and to revisit and practice skills and strengthen understandings throughout the school year.

DOMAIN TOPIC	**Quadratic Functions and Modeling** *Quadratic Functions*	**Expressions and Equations** *Structures of Expressions*	**Extending the Number System** *Quadratic Equations*	**Quadratic Functions and Modeling** *More Functions, More Features*	**Similarity, Right Triangle Trigonometry, and Proof** *Geometric Figures*	**Similarity, Right Triangle Trigonometry, and Proof** *Similarity and Right Triangle Trigonometry*	**Circles With and Without Coordinates** *Circles from a Geometric Perspectives*	**Circles With and Without Coordinates** *Circles and Other Conics*	**Applications of Probability** *Probability*
SAMPLE TIMELINE	August/ September	September/ October	October/ November	December	January	February	March	April	May/ June
CONTENT STANDARDS									
RATIONALE	In the sample above, Mathematics II begins with students extending their understanding of functions to include quadratic functions. This format starts with a mathematical concept that is new to students and incorporates opportunities to practice and expand concepts and skills developed in prior years. In the plan, students can be provided opportunities to strengthen their ability in procedural fluency, conceptual understanding, and applications.								

Steven L. Paine, Ed.D.
West Virginia Superintendent of Schools