

MATHEMATICS STANDARD

Grade – Twelfth

Standard

Benchmark

Indicators

By the end of the 11 – 12 program, students will . . .

Number, Number Sense and Operations Standard

Students demonstrate number sense, including an understanding of number systems and operations and how they relate to one another. Students compute fluently and make reasonable estimates using paper and pencil, technology-supported and mental methods.

A. Demonstrate that vectors and matrices are systems having some of the same properties of the real number system.

B. Develop an understanding of properties of and representations for addition and multiplication of vectors and matrices.

C. Apply factorials and exponents, including fractional exponents, to solve practical problems.

D. Demonstrate fluency in operations with real numbers, vectors and matrices, using mental computation or paper and pencil calculations for simple cases and technology for more complicated cases.

E. Represent and compute with complex numbers.

1. Determine what properties (closure, identity, inverse, commutative and associative) hold for operations with complex numbers.

2. Apply combinations as a method to create coefficients for the Binomial Theorem, and make connections to everyday and workplace problem situations.

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Measurement Standard

Students estimate and measure to a required degree of accuracy and precision by selecting and using appropriate units, tools and technologies.

- A. Explain differences among accuracy, precision and error, and describe how each of those can affect solutions in measurement situations.
- B. Apply various measurement scales to describe phenomena and solve problems.
- C. Estimate and compute areas and volume in increasingly complex problem situations.
- D. Solve problem situations involving derived measurements; e.g., density, acceleration.

- 1. Solve problems involving derived measurements; e.g., acceleration and pressure.
- 2. Use radian measures in the solution of problems involving angular velocity and acceleration.
- 3. Apply informal concepts of successive approximation, upper and lower bounds, and limits in measurement situations; e.g., measurement of some quantities, such as volume of a cone, can be determined by sequences of increasingly accurate approximations.

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Geometry and Spatial Sense Standard

Students identify, classify, compare and analyze characteristics, properties and relationships of one-, two- and three-dimensional geometric figures and objects. Students use spatial reasoning, properties of geometric objects, and transformations to analyze mathematical situations and solve problems.

- A. Use trigonometric relationships to verify and determine solutions in problem situations.
- B. Represent transformations within a coordinate system using vectors and matrices.

1. Use matrices to represent translations, reflections, rotations, dilations and their compositions. Derive and apply the basic trigonometric identities; i.e., angle addition, angle subtraction and double angle.
2. Relate graphical and algebraic representations of lines, simple curves and conic sections.
3. Recognize and compare specific shapes and properties in multiple geometries; e.g., plane, spherical and hyperbolic.

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Patterns, Functions and Algebra Standard

Students use patterns, relations and functions to model, represent and analyze problem situations that involve variable quantities. Students analyze, model and solve problems using various representations such as tables, graphs and equations.

- A. Analyze functions by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior.
- B. Use the quadratic formula to solve quadratic equations that have complex roots.
- C. Use recursive functions to model and solve problems; e.g., home mortgages, annuities.
- D. Apply algebraic methods to represent and generalize problem situations involving vectors and matrices.

- 1. Analyze the behavior of arithmetic and geometric sequences and series as the number of terms increases.
- 2. Translate between the numeric and symbolic form of a sequence or series.
- 3. Describe and compare the characteristics of transcendental and periodic functions; e.g., general shape, number of roots, domain and range, asymptotic behavior, extremes, local and global behavior.
- 4. Represent the inverse of a transcendental function symbolically.
- 5. Set up and solve systems of equations using matrices and graphs, with and without technology.
- 6. Make arguments about mathematical properties using mathematical induction.
- 7. Make mathematical arguments using the concepts of limit.
- 8. Compare estimates of the area under a curve over a bounded interval by partitioning the region with rectangles; e.g., make successive estimates using progressively smaller rectangles.

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- 9. Translate freely between polar and Cartesian coordinate systems.
- 10. Use the concept of limit to find instantaneous rate of change for a point on a graph as the slope of a tangent at a point.

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Data Analysis and Probability Standard

Students pose questions and collect, organize, represent, interpret and analyze data to answer those questions. Students develop and evaluate inferences, predictions and arguments that are based on data.

- A. Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.
- B. Use descriptive statistics to analyze and summarize data, including measures of center, dispersion, correlation and variability.
- C. Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.
- D. Connect statistical techniques to applications in workplace and consumer situations.

1. Identify and use various sampling methods (voluntary response, convenience sample, random sample, stratified random sample, census) in a study.
2. Transform bivariate data so it can be modeled by a function; e.g., use logarithms to allow nonlinear relationship to be modeled by linear function.
3. Describe the shape and find all summary statistics for a set of univariate data, and describe how a linear transformation affects shape, center and spread.
4. Apply the concept of a random variable to generate and interpret probability distributions, including binomial, normal and uniform.
5. Use sampling distributions as the basis for informal inference.
6. Use theoretical or experimental probability, including simulations, to determine probabilities in real-world problem situations involving uncertainty, such as mutually exclusive events, complementary events, and conditional probability.

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Mathematical Processes Standard

Students use mathematical processes and knowledge to solve problems. Students apply problem-solving and decision-making techniques, and communicate mathematical ideas.

- A. Construct algorithms for multi-step and non-routine problems.
- B. Construct logical verifications or counter-examples to test conjectures and to justify or refute algorithms and solutions to problems.
- C. Assess the adequacy and reliability of information available to solve a problem.
- D. Select and use various types of reasoning and methods of proof.
- E. Evaluate a mathematical argument and use reasoning and logic to judge its validity.
- F. Present complete and convincing arguments and justifications, using inductive and deductive reasoning, adapted to be effective for various audiences.
- G. Understand the difference between a statement that is verified by a mathematical proof, such as a theorem, and one that is verified empirically using examples or data.
- H. Use formal mathematical language and notation to represent ideas, to demonstrate relationships within and among representation systems, and to formulate generalizations.

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- I. Communicate mathematical ideas orally and in writing with a clear purpose and appropriate for a specific audience.
- J. Apply mathematical modeling to workplace and consumer situations, including problem formulation, identification of a mathematical model, interpretation of solution within the model, and validation to original problem situation.