

MATHEMATICS STANDARD

Grade – Eleventh

Standard

Benchmark

Indicators

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.

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

- 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 hold for matrix addition and matrix multiplication; e.g., use examples to show addition is commutative and when multiplication is not commutative.
2. Determine what properties hold for vector addition and multiplication, and for scalar multiplication.
3. Represent complex numbers on the complex plane.
4. Use matrices to represent given information in a problem situation.
5. Model, using the coordinate plane, vector addition and scalar multiplication.
6. Compute sums, differences and products of matrices using paper and pencil calculations for simple cases, and technology for more complicated cases.
7. Compute sums, differences, products and quotients of complex numbers.
8. Use fractional and negative exponents as optional ways of representing and finding solutions for problem situations; e.g., $27^{2/3} = (27^{1/3})^2 = 9$.
9. Use vector addition and scalar multiplication to solve problems.

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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. Determine the number of significant digits in a measurement.
- 2. Use radian and degree angle measures to solve problems and perform conversions as needed.
- 3. Derive a formula for the surface area of a cone as a function of its slant height and the circumference of its base.
- 4. Calculate distances, areas, surface areas and volumes of composite three-dimensional objects to a specified number of significant digits.
- 5. Solve real-world problems involving area, surface area, volume and density to a specified degree of precision.

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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 polar coordinates to specify locations on a plane.
- 2. Represent translations using vectors.
- 3. Describe multiplication of a vector and a scalar graphically and algebraically, and apply to problem situations.
- 4. Use trigonometric relationships to determine lengths and angle measures; i.e., Law of Sines and Law of Cosines.
- 5. Identify, sketch and classify the cross sections of three-dimensional objects.

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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. Identify and describe problem situations involving an iterative process that can be represented as a recursive function; e.g., compound interest.
2. Translate a recursive function into a closed form expression or formula for the n th term to solve a problem situation involving an iterative process; e.g., find the value of an annuity after 7 years.
3. Describe and compare the characteristics of the following families of functions: quadratics with complex roots, polynomials of any degree, logarithms, and rational functions; e.g., general shape, number of roots, domain and range, asymptotic behavior.
4. Identify the maximum and minimum points of polynomial, rational and trigonometric functions graphically and with technology.
5. Identify families of functions with graphs that have rotation symmetry or reflection symmetry about the y -axis, x -axis or $y = x$.
6. Represent the inverse of a function symbolically and graphically as a reflection about $y = x$.
7. Model and solve problems with matrices and vectors.

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8. Solve equations involving radical expressions and complex roots.
9. Solve 3 by 3 systems of linear equations by elimination and using technology, and interpret graphically what the solution means (a point, line, plane, or no solution).
10. Describe the characteristics of the graphs of conic sections.
11. Describe how a change in the value of a constant in an exponential, logarithmic or radical equation affects the graph of the equation.

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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.Design a statistical experiment, survey or study for a problem; collect data for the problem; and interpret the data with appropriate graphical displays, descriptive statistics, concepts of variability, causation, correlation and standard deviation.
- 2.Describe the role of randomization in a well-designed study, especially as compared to a convenience sample, and the generalization of results from each.
- 3.Describe how a linear transformation of univariate data affects range, mean, mode and median.
- 4.Create a scatterplot of bivariate data, identify trends, and find a function to model the data.
- 5.Use technology to find the Least Squares Regression Line, the regression coefficient, and the correlation coefficient for bivariate data with a linear trend, and interpret each of these statistics in the context of the problem situation.
- 6.Use technology to compute the standard deviation for a set of data, and interpret standard deviation in relation to the context or problem situation.

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7. Describe the standard normal curve and its general properties, and answer questions dealing with data assumed to be normal.

8. Analyze and interpret univariate and bivariate data to identify patterns, note trends, draw conclusions, and make predictions.

9. Evaluate validity of results of a study based on characteristics of the study design, including sampling method, summary statistics and data analysis techniques.

10. Understand and use the concept of random variable, and compute and interpret the expected value for a random variable in simple cases.

11. Examine statements and decisions involving risk; e.g., insurance rates and medical decisions.

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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.