

**CERTIFICATION EXAMINATIONS  
FOR OKLAHOMA EDUCATORS (CEOE™)**

**OKLAHOMA SUBJECT AREA TESTS (OSAT™)**

**FIELD 11: ADVANCED MATHEMATICS  
TEST FRAMEWORK**

**October 2005**

| <b>Subarea</b>                                       | <b>Range of Competencies</b> |
|--|------------------------------|
| I. Mathematical Processes and Number Sense           | 01–04                        |
| II. Relations, Functions, and Algebra                | 05–10                        |
| III. Measurement and Geometry                        | 11–14                        |
| IV. Trigonometry and Calculus                        | 15–19                        |
| V. Probability, Statistics, and Discrete Mathematics | 20–22                        |

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# OKLAHOMA SUBJECT AREA TESTS (OSAT™)

## FIELD 11: ADVANCED MATHEMATICS TEST FRAMEWORK

Mathematical Processes and Number Sense  
Relations, Functions, and Algebra  
Measurement and Geometry  
Trigonometry and Calculus  
Probability, Statistics, and Discrete Mathematics

### SUBAREA I—MATHEMATICAL PROCESSES AND NUMBER SENSE

#### Competency 0001

**Understand mathematical problem solving and the connections between and among the fields of mathematics and other disciplines.**

*The following topics are examples of content that may be covered under this competency.*

- Analyze and apply a variety of problem-solving strategies to various contexts.
- Select and use appropriate manipulatives and technological tools (e.g., spreadsheets, graphing utilities, statistical packages) to solve problems.
- Recognize and apply connections between and among mathematical concepts and other disciplines.
- Demonstrate knowledge of the historical development of mathematics, including contributions from diverse cultures.

#### Competency 0002

**Understand the principles and processes of mathematical reasoning.**

*The following topics are examples of content that may be covered under this competency.*

- Construct and evaluate mathematical conjectures, arguments, and proofs.
- Apply inductive and deductive reasoning to solve problems.
- Use counterexamples to formulate and evaluate arguments and disprove suppositions.
- Analyze and apply the principle of mathematical induction in proving or disproving arguments.

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**Competency 0003**

**Understand and communicate mathematical concepts and symbols.**

*The following topics are examples of content that may be covered under this competency.*

- Convert everyday language into mathematical language, notation, and symbols, and vice versa.
- Analyze, use, and perform conversions among algebraic, graphic, pictorial, and other modes of presenting and modeling mathematical concepts and relationships.
- Deduce the assumptions inherent in a given mathematical statement, expression, or definition.
- Evaluate the mathematical thinking and strategies of others.

**Competency 0004**

**Understand number theory and the principles and properties of the real and complex number systems.**

*The following topics are examples of content that may be covered under this competency.*

- Apply the properties of integers, fractions, decimals, and percents and their operations in problem-solving situations.
- Understand the fundamental principles of number theory (e.g., prime numbers, divisibility).
- Analyze and apply algebraic and geometric representations of complex numbers (e.g., polar form, vector form).
- Perform and interpret operations on complex numbers (e.g., difference, product, root; geometric interpretation of the sum).

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**SUBAREA II—RELATIONS, FUNCTIONS, AND ALGEBRA**

**Competency 0005**

**Understand the principles and properties of algebraic relations and functions.**

*The following topics are examples of content that may be covered under this competency.*

- Distinguish between relations and functions.
- Analyze relationships among different representations (e.g., tabular, algebraic, graphic) of relations and functions.
- Analyze relations and functions and their graphs in terms of domain, range, intercepts, maxima, and minima.
- Determine the effects of transformations [e.g.,  $f(x + k)$ ,  $kf(x)$ ] on the graph of a relation or function.

**Competency 0006**

**Understand the principles and properties of linear algebra.**

*The following topics are examples of content that may be covered under this competency.*

- Analyze and apply properties involving matrices (e.g., commutative property of addition, associative property of multiplication).
- Determine and analyze the inverse and determinant of a matrix.
- Represent and solve systems of linear equations using matrices.
- Determine and analyze the matrix of a linear transformation.

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**Competency 0007**

**Understand the properties of linear functions and relations.**

*The following topics are examples of content that may be covered under this competency.*

- Determine and interpret the slope and intercept(s) of a linear equation in mathematical and real-world contexts.
- Determine the equation of a line on the basis of different types of information (e.g., two points on the line, the slope and one point on the line).
- Model and solve problems involving linear equations and inequalities using algebraic and graphic techniques.
- Solve systems of linear equations and inequalities using a variety of techniques (e.g., substitution, graphing).

**Competency 0008**

**Understand the properties of quadratic and higher-order polynomial relations and functions.**

*The following topics are examples of content that may be covered under this competency.*

- Analyze relationships among tabular, algebraic, and graphic representations of quadratic and higher-order polynomial functions.
- Model and solve problems involving quadratic and higher-order polynomial equations and inequalities using a variety of techniques (e.g., completing the square, factoring, graphing).
- Analyze the zeros of quadratic and higher-order polynomial functions and apply their characteristics to solve problems.
- Analyze and use the equations and graphs of conic sections.

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**Competency 0009**

**Understand the principles and properties of rational, radical, piecewise, and absolute value functions.**

*The following topics are examples of content that may be covered under this competency.*

- Manipulate and simplify expressions involving rational, radical, piecewise, and absolute value functions.
- Describe and analyze characteristics of rational, radical, piecewise, and absolute value functions and their graphs (e.g., intercepts, asymptotes, domain, range).
- Convert between algebraic and graphic representations of rational, radical, piecewise, and absolute value functions.
- Model and solve problems involving rational, radical, piecewise, and absolute value equations.

**Competency 0010**

**Understand the principles and properties of exponential and logarithmic functions.**

*The following topics are examples of content that may be covered under this competency.*

- Apply the laws of exponents and logarithms to manipulate and simplify expressions.
- Analyze and apply the inverse relationship between exponential and logarithmic functions.
- Convert algebraic representations of exponential and logarithmic functions into graphic representations, and vice versa.
- Model and solve problems involving exponential and logarithmic functions (e.g., compound interest, exponential decay) in mathematical and real-world contexts.

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**SUBAREA III—MEASUREMENT AND GEOMETRY**

**Competency 0011**

**Understand principles and procedures related to measurement.**

*The following topics are examples of content that may be covered under this competency.*

- Apply formulas to find measures (e.g., angles, length, perimeter, area, volume) for a variety of two- and three-dimensional figures.
- Solve problems involving derived units (e.g., density, pressure, rates of change).
- Compare and convert measurements within and between customary and metric measurement systems.
- Find angle and arc measures related to circles.

**Competency 0012**

**Understand the principles and properties of Euclidean geometry in two and three dimensions.**

*The following topics are examples of content that may be covered under this competency.*

- Use the properties of lines (e.g., parallel, perpendicular) and angles (e.g., supplementary, vertical) to characterize geometric relationships and solve problems.
- Apply the principles of similarity and congruence to solve problems involving two- and three-dimensional figures.
- Apply the properties of circles (e.g., intersecting chords and secants) and polygons (e.g., numbers and lengths of sides, measures of angles) to analyze and solve problems.
- Use definitions, postulates, and theorems of geometry (e.g., Pythagorean theorem) to construct and analyze proofs.

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**Competency 0013**

**Understand the principles and properties of coordinate geometry.**

*The following topics are examples of content that may be covered under this competency.*

- Apply geometric concepts (e.g., distance, midpoint, slope) to model and solve problems.
- Apply the geometric concepts of parallel and perpendicular lines to model and solve problems.
- Use two- and three-dimensional coordinate systems to represent and analyze geometric figures.
- Represent two- and three-dimensional geometric figures in various coordinate systems (e.g., Cartesian, polar).

**Competency 0014**

**Understand the principles and properties of vector and transformational geometries.**

*The following topics are examples of content that may be covered under this competency.*

- Describe the position and movement of objects using vectors.
- Model and solve problems involving vector addition and scalar multiplication (e.g., displacement, force).
- Analyze and apply geometric transformations (e.g., translations, reflections, dilations, rotations).
- Construct and analyze figures using geometric transformations in the coordinate plane (e.g., reflecting across an axis).



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**SUBAREA IV—TRIGONOMETRY AND CALCULUS**

**Competency 0015**

**Understand the principles and properties of and relationships involving trigonometric functions and their graphic representations.**

*The following topics are examples of content that may be covered under this competency.*

- Analyze the relationships among right triangle ratios, trigonometric functions, and the unit circle.
- Analyze graphs of trigonometric functions in terms of frequency, period, amplitude, and phase shift.
- Determine the effects of transformations on the graph of a trigonometric function [e.g.,  $f(x) = a \sin(bx + c) + d$ ].
- Simplify expressions using trigonometric identities.
- Verify trigonometric identities.

**Competency 0016**

**Understand and apply the principles and techniques of trigonometry to model and solve problems.**

*The following topics are examples of content that may be covered under this competency.*

- Solve real-world problems using the trigonometry of right triangles.
- Apply trigonometric functions and relationships (e.g., law of sines) to model and solve problems involving angles, length, and area.
- Model and solve problems involving trigonometric equations and inequalities using algebraic and graphic techniques.
- Use trigonometric functions to model periodic phenomena in mathematics and other disciplines.

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**Competency 0017**

**Understand the principles and properties of limits, continuity, and average rates of change.**

*The following topics are examples of content that may be covered under this competency.*

- Apply the concept of limits to algebraic functions and their graphs.
- Analyze and interpret characteristics of functions (e.g., continuity, asymptotes) using the concept of limit.
- Recognize and apply the relationship between the slope of a secant line and the derivative of a function.
- Solve problems involving average rates of change (e.g., average velocity and acceleration).

**Competency 0018**

**Understand and apply the principles and techniques of differential calculus.**

*The following topics are examples of content that may be covered under this competency.*

- Relate the concept of the derivative to instantaneous rate of change and the concept of the slope of the line tangent to a curve.
- Find the derivative of a function.
- Use the concepts of differential calculus to analyze the graph of a function (e.g., maxima, concavity, points of inflection).
- Model and solve real-world problems (e.g., rates of change, optimization, related rates) using differential calculus.

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**Competency 0019**

**Understand and apply the principles and techniques of integral calculus.**

*The following topics are examples of content that may be covered under this competency.*

- Relate the concept of the integral to the area under a curve.
- Find the definite and indefinite integral of a function.
- Use integration in problem-solving situations (e.g., area, velocity, volume).
- Model and solve problems involving first-order differential equations (e.g., separation of variables, initial value problems).

**SUBAREA V—PROBABILITY, STATISTICS, AND DISCRETE MATHEMATICS**

**Competency 0020**

**Understand the principles, properties, and techniques of probability.**

*The following topics are examples of content that may be covered under this competency.*

- Evaluate descriptions and calculate the probabilities of different kinds of events (e.g., conditional, independent, mutually exclusive).
- Solve problems using the techniques of probability (e.g., addition and multiplication rules).
- Use and interpret graphic representations of probabilities (e.g., tables, Venn diagrams, tree diagrams, frequency graphs, the normal curve).
- Analyze and apply the properties of probability distributions (e.g., binomial, normal) to model and solve problems.

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**Competency 0021**

**Understand the principles, properties, and techniques of statistics.**

*The following topics are examples of content that may be covered under this competency.*

- Determine random sampling techniques to collect representative data.
- Display and use data in a variety of graphic formats (e.g., charts, bar graphs, circle graphs, stem-and-leaf plots, histograms, scatter plots).
- Determine, analyze, and interpret measures of central tendency (e.g., mean, median) and dispersion (e.g., standard deviation).
- Analyze and interpret statistical measures (e.g., correlation coefficients, confidence intervals, linear regression equations) and make valid inferences and predictions based on the measures.

**Competency 0022**

**Understand the principles of discrete mathematics.**

*The following topics are examples of content that may be covered under this competency.*

- Apply various counting strategies (e.g., permutations, combinations) to problem-solving situations.
- Analyze recurrence relations (e.g., Fibonacci sequence, triangular numbers) and use them to model and solve problems.
- Analyze sequences and series (e.g., arithmetic, geometric) and use them to model and solve problems.
- Apply the basic elements of discrete mathematics (e.g., graph theory, linear programming, finite difference methods) to model real-world problems.