

Department of Mathematical Sciences

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The Department of Mathematical Sciences offers the Master of Science with a major in Mathematics, the Master of Science in Teaching with a major in Mathematics, and a minor in Mathematics at the graduate level.

Three concentrations are offered under the Master of Science: General Mathematics, Industrial Mathematics, and Research Preparation. Two concentrations are offered under the Master of Science in Teaching: Middle Grade Mathematics and Secondary Mathematics.

Admission to either master's program normally requires an expected GRE score of 900 or an MAT score of 44.

Requirements for the Master of Science in Mathematics

The Master of Science in Mathematics requires a core of 9 hours plus 18 hours of specified courses in the department and a 9-hour cognate of supporting courses. Every candidate is required to declare a concentration selected from General Mathematics, Industrial Mathematics, or Research Preparation.

All candidates must

1. have completed an undergraduate prerequisite of at least 21 hours of college-level mathematics including calculus; any deficiency should be removed during the first year of study.
2. complete 36 hours including the core (9 hours), a concentration (18 hours), and a cognate area (9 hours).
3. complete at least 30 hours at the graduate level with at least 21 hours at the 6000 level.
4. participate in the graduate seminar and give an oral presentation of an approved topic.
5. file a Candidacy Form with the Graduate Office prior to the completion of 24 credit hours.
6. successfully complete a written comprehensive examination (may be taken no more than twice).

M.S. Core

Each candidate for the Master of Science in Mathematics must complete the following core (9 hours):

MATH 6120 Advanced Linear Algebra
MATH 6170 Sets and Logic
MATH 6190 Analysis I

Concentration: General Mathematics

Students desiring a broad background in mathematics should pursue this concentration. In addition to the core, students must complete the concentration and a cognate as outlined below.

Concentration

Eighteen (18) hours from approved courses in mathematical sciences, including at least one course from each of three different groups:

Algebra/Number Theory: MATH 5420, 5530, 6140, 6510

Analysis: MATH 6141, 6200, 6210, 6250

Combinatorics/Graph Theory: MATH 5700, 6700

Geometry/Topology: MATH 5270, 6400, 6142

Industrial Mathematics: MATH 5310, 5320, 6260, 6270, 6300, 6310

Cognate

Nine (9) additional hours approved by advisor

The master's thesis is an option in this concentration.

Concentration: Industrial Mathematics

Students interested in positions in industry or further graduate work in applied mathematics should pursue this concentration. In addition to the core, students must complete the concentration and a cognate as outlined below.

Concentration

Eighteen (18) hours including MATH 5310, 5320, 6260, and 6270 plus two from MATH 6210, 6300, 6310, 6400, 6410, 6700, or STAT 6160, 6180.

Cognate

Nine (9) additional hours chosen from the above list; MATH 6640, and/or courses from relevant disciplines approved by advisor.

The master's thesis is an option in this concentration.

Concentration: Research Preparation

Students wishing to pursue the Ph.D. in mathematics should choose this concentration. In addition to the core, students must complete the concentration and a cognate as outlined below.

Concentration

Eighteen (18) hours including MATH 5270, 5530, 5700, 6200, 6140, and 6210.

Cognate

Nine (9) hours including MATH 6640 and six (6) additional hours approved by advisor.

Requirements for the Master of Science in Teaching

This degree should be pursued by students interested in teaching. Admission is open to those licensed as teachers as well as those seeking initial licensure.

Candidates seeking initial licensure must meet the major requirements listed below, satisfy a professional education component, and meet discipline-related requirements. The candidate should contact the chair of the Department of Educational Leadership for the professional education component and the chair of the Department of Mathematical Sciences for the discipline-related requirements.

The Master of Science in Teaching requires the M.S.T. core of 9 hours plus 15 hours of specified courses in the department and a 12-hour cognate in professional education. Every candidate is required to declare a concentration in either Middle Grade or Secondary Mathematics.

All candidates must

1. complete 36 hours including the core (9 hours), a concentration (15 hours), and a cognate (12 hours).
2. complete at least 30 hours at the graduate level with at least 21 hours at the 6000 level.
3. file a Candidacy Form with the Graduate College prior to the completion of 24 hours credit.
4. successfully complete a comprehensive examination (may be taken no more than twice).

M.S.T. Core

Each candidate for the Master of Science in Teaching in Mathematics must complete the following core (9 hours):

- MATH 6320 Mathematical Problem Solving
MATH 6380 Current Trends in Mathematics Education
MATH 6900 Research in Mathematics Education

Concentration: Middle Grade Mathematics

Admission Requirements:

A candidate for admission to the Master of Science in Teaching program with a concentration in Middle Grade Mathematics must

1. hold a valid elementary teaching certificate.
2. have one year teaching experience.
3. submit three letters of recommendation.
4. have an acceptable GRE or MAT score. (A GRE of 900 or an MAT of 44 is expected.)

Any applicant not meeting these requirements may petition to the Mathematics Education Graduate Admissions Committee.

Degree Requirements:

In addition to the core, students must complete the concentration and cognate as outlined below.

Concentration

Fifteen (15) hours selected from MATH 5620, 6100, 6330, 6340, 6350 and other courses in the department selected in consultation with advisor.

Cognate

Twelve (12) hours in the College of Education and Behavioral Science (determined jointly by the Departments of Mathematical Sciences, Educational Leadership, and Elementary and Special Education).

Concentration: Secondary Mathematics

Admission Requirements

A candidate for admission to the Master of Science in Teaching program with a concentration in Secondary Mathematics must

1. hold a valid secondary mathematics teaching certificate, or have completed 9 hours of mathematics past the calculus sequence.*
2. have one year teaching or related work experience.
3. submit three letters of recommendation.
4. have an acceptable GRE or MAT score. (A GRE of 900 or an MAT of 44 is expected.)

Any applicant not meeting these requirements may petition to the Mathematics Education Graduate Admissions Committee.

**NOTE: Candidates seeking initial licensure may be required to complete additional hours in mathematics and/or professional education. (An advisor should be consulted.)*

Degree Requirements

In addition to the core, students must complete the concentration and cognate as outlined below.

Concentration

Fifteen (15) hours including STAT 5190, MATH 6170, and three other courses from the department selected in consultation with advisor.

Cognate

Twelve (12) hours in the College of Education and Behavioral Science (determined jointly by the Departments of Mathematical Sciences and Educational Leadership).

Courses in Mathematics [MATH]

5010 Concepts of Mathematics. Three credits. Recommended for students preparing to become elementary school teachers. Topics include complex numbers, finite mathematical systems, linear equations and inequalities, functions and their graphs, introductory matrix algebra, interest and consumer credit, and microcomputer applications in the mathematics classroom.

5200 Introduction to Mathematics of Investment. Three credits. (Same as ACSI 5200.)

5270 Introduction to Topology. Three credits. Prerequisites: MATH 3110 and a previous upper-division course in which the student has been required to write proofs. Fundamental concepts of topology including continuity, compactness, connectedness, separation axioms, and metric spaces.

5310/ 5320 Numerical Analysis I and II. Three credits each. Prerequisite: CSCI 3180 or equivalent. Application of computer-oriented numerical algorithms to algebraic equations, differential and integral equations, and linear algebra. Rigorous mathematical treatment of error included.

5420 Number Theory. Three credits. Divisibility congruences, quadratic residues, Diophantine equations, quadratic forms, and continued fractions.

5470 Introduction to Modern Algebra. Three credits. A treatment of sets, relations, operations, and the construction of number systems in algebra.

5510 Abstract Algebra I. Three credits. Groups with a brief introduction to rings, integral domains, and fields.

5530 Abstract Algebra II. Three credits. Prerequisite: MATH 4510/5510. Theory of rings, fields, integral domains, matrices, and vector spaces.

5600 Problems in Contemporary Mathematics. One to six credits. Pass/Fail grading in specified sections.

5620 History and Philosophy of Mathematics. Three credits. Prerequisites: Background in geometry, number theory, and/or symbolic logic helpful. The character of mathematical thought by way of mathematical problems which have occupied successively the outstanding mathematicians of Babylon, Egypt, Greece, China, the Renaissance, and modern times paralleled with a

study of three schools of mathematical philosophy: intuitionism, logicism, and formalism. Open only to senior and graduate mathematics majors.

- 5700 Combinatorics and Graph Theory.** Three credits. Prerequisite: MATH 2010 or 3080. Selected topics in combinatorics and graph theory emphasizing combinatorial problem solving and algorithmic proof.
- 6100 Mathematics for Teachers.** Three credits. Mathematics as problem solving, communication, and reasoning. Connecting different fields of mathematics. Topics include number and number relationships, number systems and number theory, computation and estimation, patterns and functions, statistics and probability, algebra, geometry, measurement.
- 6120 Advanced Linear Algebra.** Three credits. Prerequisite: MATH 2010. Continuation of linear algebra topics in MATH 2010 including advanced topics in inner product spaces and structure of linear operators.
- 6140 Selected Topics of Modern Mathematics: Algebra.** Three credits. Prerequisite: MATH 5530 or consent of instructor. Extension of previous work in algebra with emphasis on topics not treated in other courses.
- 6141 Selected Topics of Modern Mathematics: Analysis.** Three credits. Prerequisite: MATH 6200 or consent of instructor. Extension of previous work in analysis with emphasis on topics not treated in other courses.
- 6142 Selected Topics of Modern Mathematics: Topology.** Three credits. Prerequisite: MATH 4270/5270 or consent of instructor. Extension of previous work in topology with emphasis on topics not treated in other courses.
- 6170 Sets and Logic.** Three credits. Includes topics in three categories: 1) Propositions, predicates, quantifiers, truth tables, tautologies, and methods of mathematical proof including mathematical induction. 2) Sets, relations, functions, graphs, cardinality, and the Axiom of Choice. 3) Applications of these foundations to selected results in algebra and analysis as time permits. It is recommended that this course be taken early in the graduate program.
- 6190 Analysis I.** Three credits. Prerequisite: MATH 4250 or equivalent. Rigorous treatment of limits, continuity, differentiation, and integration in n -dimensional Euclidean space; infinite series; introduction to metric spaces.
- 6200 Analysis II.** Three credits. Prerequisite: MATH 6190 or equivalent. A continuation of MATH 6190. Lebesgue measure, Lebesgue integral, functions of bounded variation.
- 6210 Complex Variables.** Three credits. Prerequisite: MATH 6190. Theory of functions of complex variables and their application in mathematics and physics.
- 6230 Teaching of Introductory College Mathematics.** Three credits. Foundations and pertinent topics in college algebra, trigonometry, analytic geometry, and calculus with emphasis on techniques of presentation.
- 6250 Real Analysis.** Three credits. Prerequisite: MATH 6200. A continuation of MATH 6200. Advanced topics in real analysis. Abstract measure and integration theory. Introduction to functional analysis.
- 6260 Advanced Differential Equations I.** Three credits. Prerequisites: MATH 3120 and 4250. Qualitative and quantitative analysis of systems of differential equations. Gradient systems, Sturm-Liouville problems. Elementary techniques for boundary value problems of partial differential equations.
- 6270 Advanced Differential Equations II.** Three credits. Prerequisite: MATH 6260. Solution techniques for boundary value problems. Problems involve heat, wave, and potential equations. Topics include the method of characteristics, series solutions, integral transforms, and Green's functions.
- 6300 Optimization.** Three credits. Prerequisite: MATH 5320 or consent of instructor. Constrained and unconstrained optimization problems, including the generalized least squares problem and Eigenvalue problems. Methods include orthogonalization, conjugate gradient, and quasi-Newton algorithms.
- 6310 Control Theory.** Three credits. Prerequisite: MATH 6260 or consent of instructor. Vector space applications to system analysis; observability, controllability, and stabilization of systems; feedback systems; Lyapunov methods; optimal control, and the calculus variations.
- 6320 Mathematical Problem Solving.** Three credits. Prerequisite: Permission of instructor. A basis for reflection on teaching and learning mathematics. Problem-solving strategies and heuristics. Focuses on all branches of mathematics, providing an opportunity to synthesize mathematical knowledge.
- 6330 Algebra for Teachers.** Three credits. Prerequisite: Permission of instructor. Review and extension of algebraic skills and concepts as they relate to the teaching and learning of algebra. Focus on algebraic thinking and problem solving, algebraic systems, functions, graphing, and linear algebra.
- 6340 Geometry for Teachers.** Three credits. Prerequisite: Permission of instructor. Investigations into the foundations of plane, solid, and coordinate geometry, motion geometry, similarities and congruencies, measurement and the application of geometry. Instruction will model the suggested pedagogy appropriate for school mathematics.
- 6350 Probability and Statistics for Teachers.** Three credits. Prerequisite: Permission of instructor. Relation to school mathematics. Development of central tendency and variation, concepts of chance including sample space, randomness, conditional probability, and independence.
- 6360 Technology Tools for School Mathematics.** Three credits. Integrates technology into the teaching and learning process for teachers of middle and secondary school mathematics. Investigates a variety of mathematical subject matter appropriate for middle and secondary school students via technology. Lessons designed for use with a variety of technologies, including graphing calculators, dynamic geometry software, spreadsheets, authoring software, presentation software, and the World Wide Web. Highly individualized due to varying backgrounds and interests of students.
- 6380 Current Trends in Mathematics Education.** Three credits. Prerequisite: Permission of instructor. Innovative topics or critical issues related to the teaching and learning of mathematics. Includes history of mathematics education, pedagogical content knowledge, assessment and evaluation, and technologies.
- 6400 Advanced Geometry.** Three credits. Prerequisite: MATH 3070 or consent of instructor. Detailed study of one or more of the

various branches of geometry including non-Euclidean geometry, projective geometry, algebraic geometry, and differential geometry.

6410 Computer-Aided Geometric Design. Three credits. Prerequisites: MATH 5320 and 6400 or consent of instructor. Parametric curves and surfaces; Bezier and B-spline interpolation and approximation techniques; visual smoothness and parameterization for curves; Coons, Bezier, and triangular patches; scattered data methods.

6510 Advanced Algebra. Three credits. Prerequisite: MATH 5530. Polynomial rings, theory of fields, vector spaces and intermediate group theory necessary for Galois theory, and Galois theory.

6601- Problems in Mathematics. One to nine credits (in 6601-6608).

6608 Prerequisite: Mathematical maturity, preparation in the area, and normally nine semester hours of graduate study. Problems course dealing with theory methods and applications.

6601 Advanced Calculus

6602 Number Theory

6603 Mathematics of Finance

6604 Mathematics of Life Contingencies

6605 Numerical Analysis

6606 Topology

6607 Abstract Algebra

6608 Combinatorics and Graph Theory

6610 Introduction to Graduate Study. Two credits.

6640 Thesis Research. One to six credits. Selection of a research problem, review of pertinent literature, collection and analysis of data, and composition of thesis. Once enrolled, student should register for at least one credit hour of master's research each semester until completion. S/U grading.

6700 Advanced Combinatorics and Graph Theory. Three credits. Prerequisite: MATH 4700/5700. Selected topics in combinatorics and graph theory extending topics studied in MATH 4700/5700.

6900 Research in Mathematics Education. Three credits. Prerequisite: Permission of instructor. An examination of factors influencing research and critical analyses of selected research in mathematics education. Studies representing different methodologies critiqued.

6999 Comprehensive Examination and Preparation. One credit. Open only to students who are not enrolled in any other graduate course and who will take the master's comprehensive examination during the term. The student must contact the graduate advisor during the first two weeks of the term for specifics regarding the details of this comprehensive examination preparatory course. Credit may not be applied to degree requirements.

7060 Independent Study. One to nine credits.

Courses in Statistics [STAT]

5130 Applied Statistics. Three credits. Prerequisite: 2 years of high school algebra or equivalent. Topics include descriptive statistics, probability, and statistical inference. The inference unit covers means proportions and variances for one and two samples, one-way ANOVA, regression and correlation analysis, chi-square analysis, and topics in nonparametrics.

5140 Probabilistic and Statistical Reasoning. Three credits. Prerequisite: STAT 5130 or equivalent. Topics include multiple regres-

sion, variance component estimation, experimental design, covariate analysis, chi-square analysis, multiple comparisons, and nonparametrics. The experimental design topics include two-way ANOVA, factorial experiments, nested designs, and split plot designs.

5190 Mathematical Statistics II. Three credits. Prerequisite: STAT 3150 or equivalent. Theory of statistical inference. Topics include sampling distributions, decision theory, estimation, test of hypothesis, regression analysis, analysis of variance, and selected applications.

5200 Statistical Methods for Forecasting. Three credits. Prerequisite: STAT 4190. Application of the regression model in forecasting regression and exponential smoothing methods to forecast nonseasonal time-series, seasonal series and globally constant seasonal models, stochastic time series models; and forecast evaluation. (Prepares actuarial science students for the Society of Actuaries Exam #120 and Exam Part 3A administered by the Casualty Actuarial Society.)

5320 Probability and Stochastic Processes. Three credits. Prerequisite: Two semesters of calculus and STAT 3150 (or MATH 2050) or consent of instructor. Theoretical basis for stochastic processes and use as models of real-world phenomena. Topics include Markov chains, Poisson processes, and Brownian motion and stationary processes. Applications include Gambler's Ruin, birth and death models, hitting times, stock option pricing, and the Black-Scholes model.

5360 Regression Analysis. Three credits. Prerequisite: STAT 3150 or equivalent. Theory and application of regression models. Approaches to model building and data analysis treated. Computation and interpretation of results facilitated through use of statistical software packages.

5370 Nonparametric Statistics. Three credits. Prerequisite: STAT 3150 or equivalent. Statistical tests that require no assertions about parameters or about the form of the population from which the samples are drawn. A wide range of practical problems.

5380 Experimental Design. Three credits. Prerequisite: STAT 3150 or equivalent. Topics include one-way analysis of variance, multiple comparison, multifactor analysis of variance, and various practical issues in experimental design. Computation and interpretation of results are facilitated through the use of statistical software packages.

5600 Problems in Statistics. One to six credits. Prerequisites: Senior standing and consent of instructor. Students wishing to enroll must submit a written course/topic proposal to the department prior to the semester in which STAT 5600 is taken. Proposal must be approved prior to student taking the course. At the conclusion of the course, each enrollee must submit a written report to the department.

6020 Introduction to Biostatistics. One credit. Prerequisite: Introductory probability/statistics course or permission of instructor. Descriptive and inferential statistics for biostatistics including parametric and nonparametric hypothesis testing methods, sample size, statistical significance and power, survival curve analysis, relative risk, and odds ratios. Data will be analyzed using statistical software.

6160 Statistics. Three credits. Mathematical statistics and applications, discrete and continuous data, statistical inferences.

6180 Statistical Inference. Three credits. Prerequisite: STAT 6160 or permission of instructor. Theory of estimation and hypothesis

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tests. Topics include minimum variance unbiased estimation, methods of estimation, most powerful tests, likelihood ratio tests, decision theory, and sequential test procedures.

6510 Biostatistical Methods. Three credits. Prerequisites: STAT 6020 and 6160 or permission of instructor. Biostatistical methods focusing on the design and analysis of clinical trials and sample surveys. Topics include clinical trial designs and phases, bias, random error, sample size, power, estimating clinical effects, design-based methods of data analysis from sample surveys, sampling techniques, nonresponse, and sampling frame issues.

6520 Advanced Biostatistical Methods. Three credits. Prerequisites: STAT 6020 and 6160 or permission of instructor. Mathematically rigorous presentation of categorical data analysis methods for univariate and correlated multivariate responses including contingency table analysis, logistic regression, and loglinear models; survival analysis for analyzing time-to-event data including survivor functions, Kaplan-Meier curves, and Cox proportional hazards model; and other health applications of multivariate analysis methods.

6600- Problems in Statistics. One to nine credits (in 6601-6604).
6604 Prerequisite: Mathematical maturity, preparation in the area and (normally) nine semester hours of graduate study. Problems course dealing with theory, methods, and applications.

- 6601 Mathematical Statistics**
- 6602 Regression Analysis**
- 6603 Nonparametric Statistics**
- 6604 Experimental Design**

Courses in Actuarial Science [ACSI]

5140 Mathematical Foundations of Actuarial Science. Three credits. Prerequisites: ACSI/MATH 3020 (or MATH 3110) and STAT 3150 or consent of instructor. A preparatory course for the Society of Actuaries/Casualty Actuarial Society Course/Exam 1. Integrates calculus, probability, and risk management topics into fundamental tools for assessing risk in an actuarial environment. Calculus and probability topics include derivatives, integrals, partials, random variables, distributions, and conditional probability. Risk topics include frequency and severity. Insurance concepts such as retention, deductible, coinsurance, and risk premium.

5200 Introduction to Mathematics of Investment. Three credits. (Same as MATH 5200.) Prerequisites: MATH 1910 or ACSI 2020, 2030, and one semester of probability/statistics, or consent of instructor. Calculus and probability/statistics used to model and analyze investments in bonds, treasury bills, stocks, and other derivatives. Topics include obtaining the price of a bond as a function of interest rate, developing formulas for duration and convexity to study the sensitivity of price to interest rate, and mathematical modeling of investor preference and attitude toward risk.

5220 Mathematics of Pricing Theory. Three credits. Prerequisites: ACSI/MATH 4200/5200 and ECON 2410, 2420, or consent of instructor. A preparatory course for the Society of Actuaries/Casualty Actuarial Society Course/Exam 2. Applies calculus and theory of interest tools to intermediate topics in microeconomics. Topics include the mathematics of supply, demand, and equilibrium; prices, costs, and the gains from trade; consumer behavior; elasticities; competition; monopoly; market power, collusion, and oligopoly; the mathematics of risk and uncertainty; and surplus economics.

5230 Mathematics of Compound Interest. Three credits. Prerequisite: ACSI/MATH 4200/5200 or consent of instructor. A preparatory course for the Society of Actuaries/Casualty Actuarial Society Course/Exam 2. Topics include measurement of interest (including accumulating and present value factors), annuities certain, yield rates, amortization schedules, sinking funds, and bonds and related securities.

5240 Mathematics of Interest Theory, Economics and Finance. Three credits. Prerequisites: ACSI 4230/5230 or consent of instructor. A preparatory course for the Society of Actuaries/Casualty Actuarial Society Course/Exam 2. Applies calculus and theory of interest tools to intermediate topics in microeconomics and macroeconomics and topics in finance. Topics include pricing activities, the simplified Keynesian model, interest and discount rates, valuation of payment streams, yield rates, amortization, cash flows and internal rate of return, stock and bond valuation, portfolio risks, the Capital Asset Pricing Model (CAPM), efficient markets, capital structure, leverage, financial performance measurement, and basic option pricing and the Black-Scholes model.

5330 Actuarial Mathematics I. Three credits. Prerequisites: ACSI 4230/5230 and STAT 4190 or consent of instructor. First of a two-semester sequence; a preparatory course for the Society of Actuaries/Casualty Actuarial Society Course/Exam 3. Topics include survival distributions and life tables, life insurance, life annuities, and net premiums.

5340 Actuarial Mathematics II. Three credits. Prerequisite: ACSI 4230/5230 and STAT 4190 or consent of instructor. Second of a two-semester sequence; a preparatory course for the Society of Actuaries/Casualty Actuarial Society Course/Exam 3. Topics chosen from net premium reserves, multiple life functions, multiple decrement models, valuation theory and pension plans, and insurance models (including expenses and nonforfeiture benefits and dividends).

5600 Problems in Actuarial Science. One to six credits. Prerequisites: Consent of instructor. Students wishing to enroll must submit a written course/topic proposal to the department prior to the semester in which ACSI 5600 is taken. The proposal must be approved prior to student taking the course. At the conclusion of this course, each enrollee must submit a written report to the department.

5630 Mathematics of Risk Management. Three credits. Prerequisite: ACSI/MATH 4200/5200. A preparatory course for the Society of Actuaries Course 6. Topics include mathematical modeling of volatility; pricing of bonds, stocks, and other derivatives with uncertainty; benchmark portfolios; asset/liability management for property/casualty insurers; liability associated with a financially distressed company. Heath-Jarrow-Morton and Cox-Ingersoll-Ross models studied.

5640 Mathematics of Options, Futures, and Other Derivatives. Three credits. Prerequisites: ACSI/MATH 4630/5630 and 4200/5200. A preparatory course for the Society of Actuaries Course 6. Topics include risk management using options, interest rate swaps, interest rate caps, Black-Scholes analysis, Taylor series expansion to obtain hedge parameters, portfolio insurance, numerical procedures, interest rate derivatives, and use of Black's model.

6010 Credibility Theory and Loss Distributions. Three credits. Prerequisite: STAT 5190 or consent of instructor. A preparatory course for Exam Part 4B of the Casualty Actuarial Society. Topics include Bayes Theorem and its relationship to credibility theory and analysis of statistical distributions for modeling insurance claims by size.