

# Mathematics (MATH)

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## Courses

### **MATH 0900. Transitional Math I. 3 Hours.**

Designed for students with an ACT Math score of 0-17 or equivalent placement score. For students needing to learn or review basic mathematics skills. Covers operations on whole numbers, fractions, decimals, percent with applications, ratios and proportions, signed numbers, linear equations with applications, positive integral exponents, geometry, and polynomials. Graphing and polynomial factoring will be introduced. Successful completers (Grade C or higher) will be prepared to enroll in MATH 1000. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Perform arithmetical operations on whole numbers, fractions, decimals, and signed numbers without a calculator. 2. Perform mathematical processes with percentages and use them in real-life applications. 3. Use variables to represent unknown numbers. 4. Identify geometric figures and formulas and applying knowledge to angles, perimeters, areas, and volumes. 5. Use the mathematical processes of whole numbers, fractions, decimals, percentage, signed numbers, proportion/ratios, and algebraic equations with problems solving skills in real-life modeling exercises. 6. Graph linear equations in two variables by plotting points. Course fee required. FA, SP, SU.

### **MATH 0980. Transitional Math IIB. 4 Hours.**

Prepares students for courses that fulfill the General Education Math requirement for non-science and technology degrees, i.e., Math 1030 - Quantitative Reasoning and Math 1040 - Introduction to Statistics specifically. Concepts emphasized in this course include the algebra, geometry, and statistics needed to move directly into Quantitative Reasoning and Introduction to Statistics. Students will be expected to reason mathematically, apply mathematical concepts to real-world experiences, and build the foundational skills necessary for success in their next course. Students who successfully complete Math 0980 will satisfy the prerequisite for Math 1030 & Math 1040. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Develop problem-solving skills in real-world modeling exercises utilizing whole numbers, fractions, decimals, percentages, signed numbers, proportions/ratios, and algebraic equations. 2. Use algebraic processes to solve algebraic equations with one unknown. 3. Graph linear equations in two variables using various techniques. 4. Analyze and apply linear equations in two variables and their graphs to real-world problems. 5. Calculate and interpret measures of central tendency from data. 6. Compute basic probabilities theoretically and from empirical data. Course fee required. Prerequisites: Math 0900 (Grade C or higher) or ACT placement score of 12 or higher, or equivalent test score within two years of enrollment in this course. FA, SP, SU.

### **MATH 1000. Transitional Mathematics II. 4 Hours.**

Prepares students for courses that fulfill the General Education Math requirement. Concepts emphasized in this course include the properties of the real number system, sets, functions, graphs, algebraic manipulations, linear and quadratic equations, systems of equations, and story problems. Students will be expected to reason mathematically and solve mathematical problems. Successful completion of the course gives students good preparation for college-level math courses. Successful completers satisfy prerequisite for MATH 1030, MATH 1040, MATH 1050, and Mathematics prerequisite for BIOL 2030, CHEM 1110, PHYS 1010, and STAT 2040. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Perform basic mathematical operations on rational numbers with and without a calculator, including fractions, percentages, and decimals. 2. Solve algebraic, logarithmic and exponential equations in one and/or two unknowns. 3. Demonstrate the concept of equivalence including the use of variables to define relationships. 4. Use functions to analyze models of real-world problems including polynomial and quadratic equations. Course fee required. Prerequisites: MATH 0900 (Grade C or higher) OR ACT math score of 18 or higher or equivalent placement score within two years of enrollment in this course. FA, SP, SU.

### **MATH 1001. FYE: Mathematics. 1 Hour.**

A First Year Experience course created to help students succeed in the Math major, and assist new freshmen and returning students to make a successful transition to being a college student. The primary objective of this course is to provide students with the resources they will need to succeed in their college careers, particularly in the Math major. Multiple listed with all other sections of First Year Experience (all 1001 courses, ENGR 1000). Students may only take one FYE course for credit. FA.

### **MATH 1010. Intermediate Algebra. 4 Hours.**

This course is for concurrent enrollment students only. Prepares students for courses that fulfill the General Education Math requirement. Concepts emphasized include the properties of the real number system, sets, functions, graphs, algebraic manipulations, linear and quadratic equations, systems of equations, and story problems. Students will be expected to reason mathematically and solve mathematical problems. Successful completion of the course gives students good preparation for college-level Math courses. Successful completers satisfy prerequisite for MATH 1030, MATH 1040, MATH 1050, MATH 1080, and Mathematics prerequisite for CHEM 1110, IT 3050, PHYS 1010, SOC 3112, and STAT 2040. Prerequisite: MATH 0900 (Grade C or higher), OR ACT math score of 18 or higher or equivalent placement score, within two years of enrollment in this course.

**MATH 1030. Quantitative Reasoning (MA). 3 Hours.**

Fulfills General Education Mathematics requirement for students in Fine Arts, Liberal Arts, Elementary Education, and other degrees. Focuses on development of analytical problem solving skills through the application of various mathematical concepts to real-life problems. Topics include logic; financial math; problem solving; numeration systems; geometry; measurements; probability; statistics; and modeling with algebra. A class presentation is required for this course. Students are cautioned to check degree and/or transfer requirements before taking this course. \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Use algebra to graphically represent and analyze linear, quadratic, exponential, and logarithmic models. 2. Assess methods of geometry used in artistic representations of the world. 3. Identify aspects of logic used to solve complex problems and use logic to make sound decisions in personal and business life. 4. Use trigonometry to solve triangles and related applications. 5. Use principles of finance to calculate simple and compound interest, values of annuities, and amortization schedules. 6. Apply the concepts of probability to calculate outcomes and the corresponding odds in the games that people play. 7. Use statistical techniques to organize, display, and analyze data, especially as it applies to situations in the real world. Course fee required. Prerequisite: MATH 0980 or MATH 1000 or MATH 1010 (Grade C or higher), MATH 0980 recommended, or ACT math score of 20 or higher, or an equivalent placement score within two years of enrollment in this course. FA, SP, SU.

**MATH 1040. Introduction to Statistics (MA). 3 Hours.**

Fulfills General Education Mathematics requirement for students majoring in Communications, Social & Behavioral Sciences, Fine Arts, Liberal Arts, or Exercise Science. Introduction to basic concepts and methods used in statistical data analysis, includes descriptive statistics, sampling, and inferential methods while emphasizing problem solving and critical thinking. Data comparisons such as t-tests and ANOVA will also be covered. StatCrunch is used to perform statistical calculations, organize and analyze data, and construct graphs. Required for Utah Level 2 Math Endorsement. Students are cautioned to check degree and/or transfer requirements before taking this course. \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Define statistics and think statistically; distinguish between population and sample, parameter and statistic, qualitative and quantitative variables, discrete and continuous variables. 2. Organize and summarize qualitative and quantitative data using different display methods including frequency/relative frequency distribution, bar graph, pie chart, histogram, and stem-and-leaf etc.; Compute and interpret descriptive statistics, including mean, median, mode, standard deviation, and five number summary with box plot. 3. Draw and interpret scatter diagrams; compute and interpret linear correlation coefficient; find and interpret the least-squares regression line and use the line to make predictions. 4. Identify sample space and events of a probability experiment; apply probability rules including addition rule and multiplication rule; identify mutually exclusive events and independent events; solve counting problems including multiplication rule, permutation and combination; Interpret probability distributions including binomial distribution, uniform distribution and normal distribution. 5. Describe sampling distribution of sample mean and sample proportion; Construct and interpret confidence interval for population proportion, population mean and population standard deviation. 6. Test hypotheses about one sample and two samples population proportion, population mean and population standard deviation using both classical approach and p-value approach; Perform goodness-of-fit test for distributions and one-way ANOVA test for three or more means. Course fee required. Prerequisite: MATH 0980 or MATH 1000 or MATH 1010 (Grade C or higher), MATH 0980 recommended, or ACT math score of 22 or higher, or equivalent placement score within two years of enrollment in this course. FA, SP, SU.

**MATH 1050. College Algebra / Pre-Calculus (MA). 4 Hours.**

Fulfills General Education Mathematics requirement for students majoring in Business, Elementary Education, Health Sciences, Science, and other majors. Reviews fundamental algebra; explores polynomial and rational functions; introduces exponential and logarithmic functions and applications; conics; systems of linear equations and applications; arithmetic and geometric sequences and series, binomial coefficients and the Binomial Theorem; basic principle of counting. \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Graph, analyze, find intercepts, maxima, and minima of polynomial, rational, exponential, and logarithmic functions. 2. Solve non-linear and linear systems equations and inequalities using substitution, elimination, Cramer's rule, and linear programming. 3. Find terms and sums of arithmetic and geometric sequences and series, compute the terms of a binomial expression, solve counting problems. Course fee required. Prerequisite: MATH 1010 or MATH 1000 (Grade C or higher) OR ACT math score of 23 or higher, or equivalent placement score within two years of enrollment in this course. FA, SP, SU.

**MATH 1060. Trigonometry (MA). 3 Hours.**

Fulfills General Education Mathematics requirement. Continuation of MATH 1050, utilizes unit circle and right triangle definitions, graphs of trigonometric functions, solving trigonometric equations, and verifying trigonometric identities. Involves polar and parametric functions, vectors, and conic sections. Required for Utah Level 2 and Level 3 Math Endorsements. \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Manipulate and evaluate trigonometric functions. 2. Use proofs to work with trigonometric functions to prove trigonometric identities. 3. Demonstrate the ability to use trigonometric identities to solve real world applications. 4. Use vectors geometrically and algebraically to solve problems. Course fee required. Prerequisite: MATH 1050 (Grade C or higher) ACT math score of 25 or higher, or equivalent placement score within two years of enrollment in this course. FA, SP, SU.

**MATH 1080. Pre-Calculus with Trigonometry (MA). 5 Hours.**

Fulfills General Education Mathematics requirement. Provides in-depth review of college algebra and trigonometry before entering trig-based calculus by reviewing concepts taught in MATH 1050 and MATH 1060. Successful completion fulfills prerequisite for MATH 1210, and Mathematics prerequisite for PHYS 2010. \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Analyze the key components of the graphs of polynomial and rational functions. 2. Solve real-world applications by applying trigonometric functions. 3. Derive new trigonometric identities through proper application of established identities. 4. Apply the algebraic and geometric techniques of vectors to solve problems. Prerequisite: MATH 1010 or MATH 1000 (Grade B or higher), or ACT math score of 25 or higher, or equivalent placement score within two years of enrollment in this course. FA, SP.

**MATH 1100. Business Calculus (MA). 3 Hours.**

Fulfills General Education Mathematics requirement. Required of majors in the Udvar-Hazy School of Business, as well as students majoring in Computer & Information Technology. Emphasizes functions, modeling, differentiation, applications of differentiation, exponential and logarithmic functions, integration, applications of integration, and functions of several variables. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Discuss and analyze the concepts of limits and the interrelationships of the graphic, numeric, and symbolic approaches to limits. 2. Discuss and analyze functions by computing and interpreting their first and second derivatives. 3. Apply basic calculus techniques to data and functions that serve to model real-life applications in career areas such as business, economics, social science, and architecture. 4. Apply the definite integral as the limit of a sum to applications in business, economics, sociology, ecology, and other areas. Course fee required. Prerequisite: MATH 1050 (Grade C or higher), ACT math score of 25 or higher, or equivalent placement score within two years of enrollment in this course. FA, SP, SU.

**MATH 1210. Calculus I (MA). 4 Hours.**

Fulfills General Education Mathematics requirement. Students will gain a basic understanding of calculus, including limits and derivatives, differentiation rules, applications of differentiation and integrals. Students must have a working knowledge of college algebra and trigonometry. Required for Utah Level 2, 3, and 4 Math Endorsements, and for students majoring in Computer Science, Computer and Information Technology--Software Development Emphasis, Biology, Physical Science Composite Teaching and Pre-engineering. Successful completion fulfills prerequisite for MATH 1220, and Mathematics prerequisite for ENGR 2010 and PHYS 2210. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Evaluate limits algebraically, numerically, graphically, and through L'Hospital's Rule. 2. Apply the definition of a derivative and derivative rules to differentiate functions, and then apply the derivative in solving real world problems. 3. Perform integration by various techniques. 4. Compute the area under a curve through approximation techniques, and through proper use of the definite integral. Prerequisite: MATH 1050 AND MATH 1060 (Grade C or higher); OR MATH 1080 (Grade C or higher); OR ACT or equivalent placement score 26 or higher; OR CPT placement score of 105 or higher within two years of enrollment of this course. FA, SP, SU.

**MATH 1220. Calculus II (MA). 4 Hours.**

Fulfills General Education Mathematics requirement. Continuation of MATH 1210, covering applications of integration, differential equations, infinite sequences and series. Required for Utah Level 3 and 4 Math Endorsements, and for students majoring in Mathematics, Chemistry, Computer Science and Physical Science Composite Teaching. Successful completion fulfills prerequisite for MATH 2210, and Mathematics prerequisite for ENGR 2250, ENGR 2300, and PHYS 2220. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Develop a basic understanding of advanced integration techniques, including approximate integration. 2. Use integrals to formulate and solve application problems in science, engineering, biology, and economics. 3. Using the techniques of differential equations to predict population growth and decay. 4. Demonstrate knowledge of sequences and series including tests for convergence and methods of approximation of sums. 5. Explore methods of determining convergence and evaluation limits of sequences and series. Prerequisite: MATH 1210 (Grade C or higher). FA, SP, SU.

**MATH 2010. Math for Elementary Teachers I. 3 Hours.**

The first course in a 2-semester sequence of mathematics appropriate to the needs of elementary and middle school teachers. Includes problem solving, sets, numeration systems, whole numbers, algorithms of arithmetic, number theory, rational numbers and decimal numbers. Required for Utah Elementary Education (Level 1) and Level 2 Math Endorsements. **\*\*COURSE LEARNING OUTCOMES (CLOs)** Demonstrate competent problem solving skills. 2. Demonstrate knowledge of spatial and visual mathematical thinking. 3. Effectively communicate orally and in written form mathematical concepts and mathematical reasoning. 4. Demonstrate a knowledge of mathematics thinking required to fully understand k-6 curriculum. 5. Demonstrate a knowledge of, and ability to, connect elem. mathematics concepts to physical objects. Prerequisite: MATH 1030 (Grade C or higher) or MATH 1050 (Grade C or higher), MATH 1030 preferred. FA, SP.

**MATH 2020. Math for Elemen Teachers II. 3 Hours.**

The second course in a 2-semester sequence of mathematics appropriate to the needs of elementary and middle school teachers. Continuation of Math 2010. Includes real numbers, statistics, probability, geometry, measurement, and algebra. Required for Utah Elementary Education (Level 1) and Level 2 Math Endorsements. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Demonstrate various viewpoints of mathematical thinking. 2. Demonstrate competent problem solving skills. 3. Show examples of spatial and visual mathematical thinking. 4. Effectively communicate orally and in written form mathematical concepts and mathematical reasoning. 5. Demonstrate a knowledge of mathematics thinking required to fully understand k-6 curriculum. Prerequisite: MATH 2010 (Grade C or higher). FA, SP.

**MATH 2050. Applied Statistics with Programming. 3 Hours.**

This course provides an introduction to statistical programming from describing raw data (descriptive statistics) to making statistical conclusions (inferential statistics) based on real data from practical problems. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Interpret, summarize and graph practical data set using statistical programming. 2. Conducting appropriate statistical analysis of practical data set using statistical programming. 3. Interpret and understand the results of statistical analyses from statistical program. 4. Able to make conclusions and decisions based on the statistical analysis results. Prerequisites: MATH 1040 (Grade C or higher) or STAT 2040 (Grade C or higher). FA.

**MATH 2200. Discrete Mathematics. 3 Hours.**

Introduction to proofs and writing Mathematics. Covers Logic (including Boolean), Sets, Functions, Equivalence Relations, Modular Arithmetic, and Graph Theory. Also covers prepositional calculus, combinatorics, and Counting Methods. Prerequisite: MATH 1210 (Grade C or higher). FA, SP.

**MATH 2210. Multivariable Calculus (MA). 4 Hours.**

Fulfills General Education Mathematics requirement. Continuation of MATH 1220. Includes vectors and the geometry of space, vector functions, partial derivatives, multiple integrals, and vector calculus. Required for Utah Level 3 and Level 4 Endorsement. Prerequisite: MATH 1220 (Grade C or higher). FA, SP.

**MATH 2250. Differential Equations and Linear Algebra. 4 Hours.**

Linear systems, abstract vector spaces, matrices through eigenvalues and eigenvectors, solution of ode's Laplace transform, first order systems. For Engineer majors. Covers the following methods of solving ordinary differential equations (along with applications of such): separation of variables, homogenous and non-homogeneous, exact, first-order and higher, integrating factors, substitution methods, linear and non-linear, complex characteristics, variation of parameters, undetermined coefficients (superposition and annihilator approach), and Euler-Cauchy. Will introduce power series solutions, and the Laplace transform. Covers matrix and vector analysis, linear dependence and independence, matrix algebra, diagonalization, eigenvalues and eigenvectors, linear transformations (kernel and range), and vector spaces and subspaces (including null, column, and bases). **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Solve ordinary differential equations via the use of the following solution types: exact, implicit, series, and discrete application. 2. Solve systems of linear ordinary differential equations via the use of differential operators, Laplace transformations, and matrix methods. 3. Utilize ordinary differential equations as well as systems thereof to obtain solutions to related application problems. Prerequisites: Math 1220 (Grade C or higher). SP.

**MATH 2270. Linear Algebra. 3 Hours.**

For Mathematics and pre-Engineering majors. Covers matrix and vector analysis and systems of equations with applications, linear dependence and independence, matrix algebra and invertibility, determinants and their applications, Cramer's Rule, diagonalization, eigenvalues and eigenvectors, linear transformations (kernel and range), inner product, orthogonality, vector spaces and subspaces, including null and column and bases as well as introducing basic proof theory. Required for Utah Level 3 and 4 Math Endorsements. Prerequisite: MATH 1210 (Grade C or higher). FA, SP.

**MATH 2280. Ordinary Differential Equations. 3 Hours.**

For Mathematics and pre-Engineering majors. Covers methods of solving ordinary differential equations with applications: separation of variables, homogeneous and non-homogeneous, exact, first and higher order, integrating factors, substitution methods, linear and non-linear, complex characteristic roots, variation of parameters, undetermined coefficients (superposition and annihilator approach), and Euler-Cauchy. Systems of equations, power series solutions, and the Laplace transform will be introduced. Required for Utah Level 4 Math Endorsement. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Solve ordinary differential equations via the use of the following solution types: exact, implicit, series, and discrete application. 2. Solve systems of linear ordinary differential equations via the use of differential operators, Laplace transformations, and matrix methods. 3. Utilize ordinary differential equations as well as systems thereof to obtain solutions to related application problems. Prerequisite: MATH 1220 (Grade C or higher). SP.

**MATH 2989. TI-89 Calculator Skills. 1 Hour.**

Designed to aid students in using the TI-89 (or similar) calculator through a study guide, demonstrations, and hands-on experience. Covered features include basic computation, matrices, graphing, and calculus applications. Each student must own or have access to a TI-89, TI-92, or TI Voyage 200 calculator. FA, SP.

**MATH 2990. Seminars in Math. 0.5-3 Hours.**

For students wishing instruction that is not available through other regularly scheduled courses in this discipline. Occasionally, either student demand for some type of non-traditional instruction, or an unanticipated opportunity for instruction presents itself. The seminar courses provides a variable credit context for these purposes. This seminar course must first be pre-approved by the department chair; second, it must provide at least nine contact hours of lab or lecture for each credit hour offered; and third, it must include some academic project or paper (i.e., credit is not given for attendance alone). This course may include standard lectures, travel and field trips, guest speakers, laboratory exercises, or other non-traditional instruction methods. Note that this course is an elective and does not fulfill general education or program requirements. Prerequisite: Instructor permission.

**MATH 3000. History of Mathematics. 3 Hours.**

Selected topics in mathematics developed from ancient to modern times and the study of biographies of prominent mathematicians. Required for Utah Level 4 Math Endorsement. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Learn the development of mathematics in various areas of mathematics such as Algebra and Calculus. 2. Learn the contributions of a variety of cultures to the development of mathematics. 3. Learn how to solve mathematics problem in the style of each culture under study. Prerequisite: MATH 1220 (Grade C or higher). FA (odd).

**MATH 3100. Euclidean / Non-Euclidean Geom. 3 Hours.**

Includes axiomatic development of Euclidean and non-Euclidean geometry. Computer-based GeoGebra program is used. Required for Utah Level 3 and 4 Math Endorsements. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand the role of axioms in Euclidean and Non-Euclidean geometry. 2. Proficiently write geometric rigorous proofs. 3. Use technology to explore and conjecture geometric results. Prerequisite: MATH 2200 (Grade C or higher). SP (odd).

**MATH 3150. Introduction to Partial Differential Equations. 3 Hours.**

First-Order Partial Differential Equations (PDEs), Second-Order PDEs, Fourier Series, The Heat Equation, The Wave Equation, Laplace's Equation, The Fourier Transform Methods for PDEs. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand the wave, heat, and Laplace equations and their applications. 2. Utilize Fourier series and the Fourier transform to solve partial differential equations. 3. Understand Sturm-Liouville eigenvalue problems and receive an introduction to solving PDEs numerically. Prerequisite: MATH 2210 and MATH 2270 and MATH 2280 (all Grade C or higher). FA (odd).

**MATH 3200. Introduction to Analysis I. 3 Hours.**

For students interested in advanced Mathematics. Introduces the construction of rigorous proofs of mathematical claims in beginning analysis. Required for Utah Level 4 Math Endorsement. Prerequisite: MATH 2200 (Grade C or higher); AND MATH 2210 (Grade C or higher). FA (odd years).

**MATH 3210. Introduction to Analysis II. 3 Hours.**

Continuation of MATH 3200. Includes continuity, differentiation, chain rule, Riemann integration, Fubini's theorem, and change of variable formula.

**\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Explain, in mathematical terms, the definitions (e.g., continuity, partial differentiability, Riemann and Lebesgue integrability, etc.) and theorems (e.g., Fubini's theorem, the change of variables formula, etc.) underlying advanced and multivariable calculus. 2. Articulate and discriminate between such notions as continuity and uniform continuity (as applied in describing functions), pointwise and uniform convergence (as applied both in describing sequences of functions and in describing power series), and Riemann and Lebesgue integrability (as applied in describing functions). 2. Identify the notational subtleties and, in the case of Riemann and Lebesgue integrability, the constructional considerations responsible for the variance between the definitions of these terms. 3. Create and analyze rigorous arguments in the mathematical language that demonstrate both a thorough command of accepted notation and terminology as well as a strong understanding of both introductory and intermediate real analysis. Prerequisite: MATH 3200. SP (even).

**MATH 3400. Probability & Statistics. 3 Hours.**

Mathematics-based statistics. Topics include: Concepts in probability, discrete, continuous and bivariate distributions, distributions of functions of random variables, point and interval estimation, tests of hypothesis, and regression. Calculators with statistical functions is required. Required for Utah Level 3 and 4 Math Endorsement.

**\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand properties of probability, counting Techniques, conditional probability and Bayes' Theorem. 2. Understand Discrete random variables and Discrete distributions like Binomial, Negative binomial and Poisson distributions. 3. Understand Continuous random variables and Continuous distributions like Normal, Exponential, Gamma and Chi-square distributions. 4. Understand Bivariate distributions of discrete and continuous type. 5. Understand Distributions of functions of one, two or several random variables, Moment-Generating functions and central limit theorem. 6. Take the Actuarial Probability exam (SOA Exam P). Prerequisite: MATH 1220 (Grade C or higher). SP (odd).

**MATH 3410. Actuarial Exam P/1 Preparation. 1 Hour.**

Recommend students to take this class at the same semester as Math 3400. Prepare for Exam P/1 by working on sample exam questions.

Prerequisites: MATH 3400 (Grade C or higher, can be concurrently enrolled). FA, SP.

**MATH 3450. Statistical Inference. 3 Hours.**

Topics include: point estimation, maximum likelihood estimators and their distributions, sufficient statistics, and Bayesian estimation, confidence intervals for means and proportions, distribution-free confidence intervals for percentiles, confidence intervals for regression coefficients, and re-sampling methods, test hypothesis for means and proportions, The Wilcoxon tests, the power of a test, best critical regions and likelihood ratio tests,, standard chi-square tests, analysis of variance including general factorial designs, and some procedures associated with regression, correlation and statistical quality control.

**\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand and implement point estimation and interval estimation. 2. Understand and utilize various test hypotheses including tests for mean, proportions, chi-square test, one-way ANOVA, two-way ANOVA and more. Prerequisites: MATH 3400 (Grade C or higher). FA.

**MATH 3500. Numerical Analysis. 3 Hours.**

Includes numerical solutions of nonlinear equations, interpolation and approximation, numerical integration and differentiation, and solutions of linear systems, numerical solutions of ordinary and partial differential equations, using Maple software to implement various algorithms numerically.

**\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Identify issues of round-off error in numerical approximation using computers/technology. 2. Discuss stability of algorithms, rate of convergence, absolute error and relative error. 3. Implement different root finding algorithms. 4. Construct and use Lagrange polynomials for interpolation and approximation of continuous functions. 5. Implement other types of interpolation methods and perform numerical differentiation and integration methods. 6. Numerically solve ordinary differential equations with initial values. Prerequisites: MATH 2270 AND MATH 2280. FA (even).

**MATH 3770. Mathematical Modeling I. 4 Hours.**

Development of mathematical models arising in various areas of applications including the mathematical sciences, operations research, engineering and the management and life sciences, and their solution using a wide variety of tools.

**\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Assess and articulate what type of modeling techniques are appropriate for a given dynamical system. 2. Construct a mathematical model of a given dynamical system and analyze it. 3. Make predictions of the behavior of a given dynamical system based on the analysis of its mathematical model. 4. Develop facility in interpreting mathematical models and the conclusions based on the models. Corequisites: MATH 2280. Prerequisites: MATH 1220 (Grade C or higher) and MATH 2270 (Grade C or higher). FA.

**MATH 3900. Number Theory. 3 Hours.**

Overview of number theory and its applications, including the integers, factorizations, modular arithmetic, congruencies, Fermat's and Euler's

Theorems, diophantine equations, cryptography, and RSA algorithm. Required for Utah Level 4 Math Endorsement. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Define and investigate divisibility, modular arithmetic, primitive roots, and number theoretic functions. 2. Apply number theory to coding and/or cryptography. 3. Use technology to solve number theoretic applications. 4. Produce rigorous proofs in the context of number theory. Prerequisite: MATH 2200. SP (even).

**MATH 4000. Foundations of Algebra. 3 Hours.**

For students in all Math-related majors. Covers an introduction to algebraic systems including group rings, fields and sets. Required for Utah Level

3 and 4 Math Endorsements. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand and use the definition and basic properties of groups, rings, and fields. 2. Analyze and prove examples of subgroups, normal subgroups, and quotient groups. 3. Use the concepts of homomorphism and isomorphism for groups, rings, and fields. 4. Produce rigorous proofs in the context of Abstract Algebra. Prerequisite: MATH 2200. FA (even).

**MATH 4010. Abstract Algebra. 3 Hours.**

Continuation of MATH 4000. Topics include Sylow Theory for finite groups, Galois Theory, factorization in commutative rings. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand and explore advanced topics in group theory, ring theory, and field theory. 2. Demonstrate understanding by applying classical topics such as the Sylow theorems and Galois theory to concrete examples of algebraic structures. 3. Explore the application of abstract algebra to areas such as geometry, public-key cryptography, error-correcting codes, etc. 4. Produce rigorous proofs in the context of abstract algebra. Prerequisite: MATH 4000. SP (odd).

**MATH 4100. Introduction to Topology. 3 Hours.**

Overview of elementary point-set topology. Includes topological spaces, compactness, connectedness, metric spaces, and Hausdorff spaces. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand the concepts of and prove fundamental results in point-set topology as needed for advanced work in the mathematical sciences. 2. In particular, develop the ideas of a topology, basis, the Hausdorff property, connectedness, continuous mappings, compactness, and related concepts; create new topological spaces using the product topology, subspace topology, and quotient topology. 3. Explore the application of topology to areas such as digital image processing, geographical information systems, robotics, etc. 4. Produce rigorous proofs in the context of topology. Prerequisites: MATH 2200 AND MATH 2210. FA (odd).

**MATH 4200. Introduction to Complex Analysis. 3 Hours.**

Overview of basic theory and applications of complex variables, including analytic functions, contour integration, and conformal mappings. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand arithmetic, algebraic, geometric properties of complex numbers and basic complex functions (mappings). 2. Understand calculus concepts like limit, continuity, and derivatives of elementary complex analytic functions in particular with complex exponential, logarithmic, power, trigonometric, hyperbolic, inverse trigonometric, and inverse hyperbolic functions. Understand how those functions act as mappings of the complex plane. 3. Define integral of complex functions (contour integral). Understand the properties of contour integral and method of evaluation in the complex plane. 4. Understand complex sequences and series including power series, Taylor series, and Laurent series; Implement basic convergent/divergent tests. Understand residual theorem, Laplace transformation, and Fourier Transformation. 5. Understand and utilize conformal mapping to solve boundary-value problems in heat flow, electrostatics, and fluid flow. Prerequisite: MATH 3200. SP (even).

**MATH 4250. Programming for Scientific Computation. 4 Hours.**

This course introduces the essentials of scientific computer programming using appropriate high-level languages to solve problems in engineering and science. Programming topics include problem decomposition, control structures, recursion, arrays and other data structures, file I/O, graphics, code libraries, round-off error in floating point arithmetic. Applications will be drawn from numerical integration and differentiation, root finding, matrix operations, searching and sorting, simulation, and data analysis. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Demonstrate proficiency in basic skills related to using MATLAB/Python in scientific computation setting. 2. Apply programming skills to solving challenging problems that are either purely mathematical or arise from other disciplines. Prerequisites: CS 1400 (Grade C or higher) and MATH 2270 (Grade C or higher). Corequisites: MATH 2280. SP.

**MATH 4400. Financial Mathematics. 3 Hours.**

This course focuses on the theoretical basis and mathematical analysis of financial mathematics. This course prepares actuarial students for exam FM in the Society of Actuaries' series (or Exam 2 for the Casualty Actuarial Society). **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Demonstrate the ability to define and recognize terms regarding time value of money. 2. Solve problem related to time value of money. 3. Define and recognize terms regarding annuity. 4. Solve problem related to loans and bonds. 5. Define and recognize terms regarding immunization. 6. Construct various investment portfolio. 7. Take the Actuarial Financial Mathematics Exam (SOA Exam FM/CAS Exam 2). Prerequisites: MATH 1100 (Grade C or higher) or MATH 1210 (Grade C or higher). SP.

**MATH 4410. Actuarial Exam FM/ 2 Preparation. 1 Hour.**

Recommend for students to take this class the same semester as MATH 4000. Prepare for Exam FM/2 by working on sample exam questions. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Demonstrate through testing the ability to take the Actuarial Financial Mathematics Exam (SOA Exam FM/CAS Exam 2) Prerequisites: MATH 4400 (Grade C or higher, can be concurrently enrolled). FA, SP.

**MATH 4500. Methods Teach Secondary Math. 3 Hours.**

Designed for pre-service secondary math teachers or those seeking Utah Level 2, 3, 4 Mathematics Endorsement. Course content includes use of curriculum and research in the 7- 12 grade classroom, development of math pedagogical skills, accommodations for diverse learners, factors of motivation, and professional growth. Technology will include graphing calculators, classroom on-line learning systems, and mathematical instructional software. Required for Utah Level 2, 3, and 4 Math Endorsements. **\*\*COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Understand procedures in Secondary classroom. 2. Demonstrate proficiency in teaching 7-12 mathematics. 3. Demonstrate knowledge of methods of teaching mathematics. 4. Demonstrate knowledge of mathematical learning schema of 7-12 students. Prerequisite: MATH 1210 (Grade C or higher). FA.

**MATH 4550. Scientific Computation. 3 Hours.**

Advanced numerical linear algebra, optimization, nonlinear systems, topics from approximation theory, quadrature, numerical solutions of differential equations. \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Demonstrate an understanding of the concepts of efficiency and stability of algorithms in numerical linear algebra. 2. Understand the importance of matrix factorizations, and know how to construct some key factorizations using elementary transformations. 3. Solve linear systems, least squares problems, and the eigenvalue problems. 4. Appreciate the issues involved in the choice of algorithm for particular problems (sparsity, structure, etc.). 5. Appreciate the basic concepts involved in the efficient implementation of algorithms in a high-level language. Prerequisites: MATH 3500 (Grade C or higher). SP (odd).

**MATH 4800. Industrial Careers in Mathematics. 3 Hours.**

Students will work in teams on a project from an industrial firm. This course is designed to expose students to the types of problems solved by mathematicians working in business, government, or industry. Students will be given a real-life problem and asked to work on a solution over the course of the semester. Student success will depend on realistic industry evaluations such as teamwork, communication, individual initiative, and final products. Advanced Standing (Math 4800 is a course for students with strong mathematical preparation.) \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Experience how Math is done in the real world. 2. Develop, test, and implement a mathematical model of their own devising. 3. Assess and revise their own results in order to arrive at a solution that meets the practical constraints of the client. 4. Collaborate in small teams working toward a common goal. 5. Improve their communication skills by presenting and clarifying technical results. 6. Become acquainted with non-academic stakeholders in business, industry, and government. 7. Prepare for a potential career in Industrial Mathematics and increase awareness about the growing pool of non-academic careers. Prerequisites: Instructor permission required. FA, SP.

**MATH 4890R. Independent Research. 1-3 Hours.**

Designed to meet the individual needs of advanced students in the Math Department who wish to perform an independent research to answer a specific mathematical question. This course is offered by arrangement with an individual faculty, based on preparation and interest, and allows close interaction between the student and faculty member to address specific mathematical problems. Projects are at the discretion of the faculty member, in line with the student's interests in the various mathematics subject areas. The student and faculty will set expectations and grading policies at the beginning of the term. Students are expected to meet with the faculty mentor each week and to provide the faculty mentor with progress reports and assignment development for feedback. Prerequisite: Instructor permission required. FA, SP, SU.

**MATH 4900. Senior Capstone Seminar. 3 Hours.**

Independent Study. Required of all Mathematics majors in the senior year. Emphasizes the ability to analyze and communicate mathematically through projects to include researching topics, summarizing journal articles, using a technical documentation system such as LaTeX or Equation Editor, and making oral class presentations. Preparation for and completion of standardized exit exam is required. \*\*COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Identify research topics and problems of interest to them. 2. Read, interpret, analyze, and possibly expand upon ideas contained in modern mathematical research papers. 3. Write, in the mathematical language, research articles and papers that meet the current stylistic standards for publication within reputable scientific journals. 4. Utilize the TeX/LaTeX typesetting environment and the associated Beamer document class to produce technical and mathematical papers, together with accompanying slideshows that meet the current formatting standards for circulation, dissemination, and presentation within the scientific community. 5. Give well-organized, precise, and compelling oral presentations of their findings. Course fee required. Prerequisite: Senior standing; and Mathematics major. FA, SP.