Developmental Mathematics

Note: MATH 0910, MATH 0920 and MATH 0930 are hybrid courses using an interactive online learning environment. These courses require students to work online to complete course requirements, some of which will occur during class time.

MATH 0910 Developmental Mathematics I (4)

First of two courses reviewing fundamental concepts, geometry, basic data analysis, and introductory algebra. Topics include: operations and ordering of real numbers; plotting on the number line; algebra of polynomial expressions; linear equations; linear inequalities in one variable; equations and graphs of lines; systems of linear equations; graphical representations of data; mean, median and mode; estimation and prediction; introduction to counting and probability; perimeter, area, and volume; angles in the plane; special triangles; congruence; Pythagorean Theorem; parallel and perpendicular lines. Emphasis is on applications of concepts. Course does not count toward graduation. Prerequisite: A score of 40 or below on the ELM. If the CSU Entry Level Mathematics requirement has already been satisfied, department permission is required for enrollment in this course. 200 minutes lecture/discussion per week.

MATH 0920 Developmental Mathematics IIA (4)

Second of two courses reviewing fundamental concepts, geometry, basic data analysis, and intermediate algebra. This course is intended for students pursuing a non-technical major. Topics include: functions; algebra of polynomial expressions; factoring; systems of linear equations; absolute value and quadratic equations; linear inequalities in one variable; graphs of linear and quadratic functions. Emphasis is on applications of concepts. Earning a C- or better in this course satisfies the Entry Level Mathematics requirement but does not count toward graduation. Prerequisite: (1) A score of 42-48 on the ELM; or (2) a grade of C- or better in MATH 910. If the CSU Entry Level Mathematics requirement has already been satisfied, department permission is required for enrollment in the course. 200 minutes/discussion per week. Note: This course is a prerequisite only for the A4 General Education Courses MATH 1009 and 1209. It will not serve as a prerequisite for MATH 1040, 1050, 1300, 2200 or 3100. A student changing from a non-technical major to a technical major will be required to satisfy MATH 930. Quarter course prerequisite: D- or better in MATH 75.

MATH 0930 Developmental Mathematics IIB (4)

Second of two courses reviewing fundamental concepts, geometry, basic data analysis, and intermediate algebra. **This course is intended for students pursuing a major in science, engineering, technology, business, or a teaching credential.** Topics include: functions; algebra of polynomial, rational, and radical expressions; factoring; introduction to rational exponents; systems of linear equations; absolute value, quadratic, rational, and radical equations; linear inequalities in two variables; graphs of linear and quadratic functions; midpoint and distance formulas; ratio, proportion and similar triangles; square and higher-order roots. Emphasis is on applications of concepts. Earning a C- or better in this course satisfies the Entry Level Mathematics requirement but does not count toward graduation. Prerequisite: (1) A score of 42-48 on the ELM; or (2) a grade of C- or better in MATH 910. If the CSU Entry Level Mathematics requirement has already been satisfied, department permission is required for enrollment in this course. 200 minutes lecture/discussion per week. NOTE: THIS COURSE IS A PREREQUISITE FOR MATH 1040, 1050, 1300, 2200 AND 3110. IT WILL ALSO SERVE AS A PREREQUISITE/COREQUISITE FOR THE A4 GENERAL EDUCATION COURSES MATH 1009 AND 1209. Quarter course prerequisite: D- or better in MATH 75.

Lower Division

MATH 1009 Modern Math and Applications (3)

A survey of topics in modern mathematics. Lectures will focus on the uses of mathematics in areas such as a social choice, management science, growth, symmetry, and statistics. Prerequisite: (1) ELM score of 50 or higher, or (2) SAT (Math) score of 550 or higher, or (3) ACT (Math) score of 23 or higher, or (4) grade of C- or better in MATH 920. 150 minutes lecture/discussion per week. Note: (1) A grade of C or better in the course satisfies the A4 General Education requirement. GE A4. (2) Class may be taken concurrently with MATH 920 or MATH 930. Quarter course prerequisite: D- or better in MATH 85. Satisfies general education requirement A4.

MATH 1020 College Algebra, Dual Credit Program (3)

This course is the first half of the Precalculus course sequence. Topics include: polynomial, rational, exponential, and logarithmic functions, the fundamental theorem of algebra, and applications. Open only to students in the dual-credit portion of the CSUB Early Enrollment Program.

MATH 1030 College Algebra and Trigonometry, Dual Credit Program (3)

This course is a combined version of College Algebra and Trigonometry. Topics include: polynomial, rational, exponential, and logarithmic functions, the fundamental theorem of algebra, trigonometric functions, analytic trigonometry, vectors, polar equations, parametric equations, conic sections, and applications. Open only to students in the dual-credit portion of the CSUB Early Enrollment Program.

MATH 1040 Precalculus I and II Combined (6)

This course is a combined version of Precalculus I and II. Topics include: polynomial, rational, exponential, and logarithmic functions, the fundamental theorem of algebra, trigonometric functions, analytic trigonometry, vectors, polar equations, parametric equations, conic sections, and applications. Prerequisites: (1) B or better in MATH 0930; or (2) Satisfaction of the Entry Level Mathematics requirement

and a score of 65 or higher on the Math Placement Exam. 300 minutes lecture/discussion per week. Quarter course prerequisites: B or better in MATH 85.

MATH 1050 Precalculus I (4)
This course is the first half of the Precalculus Sequence. Topics include: polynomial, rational, exponential, and logarithmic functions, the fundamental theorem of algebra, and applications. Prerequisite: Student must satisfy at least one of the following four requirements (1) ELM score of 50 or higher, or (2) SAT (Math) score of 550 or higher, or (3) ACT (Math) score of 23 or higher, or (4) C- or better in MATH 0930. Note: Students are strongly encouraged to enroll in MATH 1051 before or concurrently with MATH 1050. 200 minutes lecture/discussion per week. Quarter course prerequisites: D- or better in MATH 85.

MATH 1051 Precalculus I Supplement (1)
This course, a supplement to MATH 1050, reinforces basic algebraic skills including exponents, roots, and factoring. Prerequisite: Student must satisfy at least one of the following four requirements (1) ELM score of 50 or higher, or (2) SAT (Math) score of 550 or higher, or (3) ACT (Math) score of 23 or higher, or (4) C- or better in MATH 0930. CR/NC only. Note: Students are strongly encouraged to enroll in MATH 1051 before or concurrently with MATH 1050. 50 minutes lecture/discussion per week. Quarter course prerequisites: D- or better in MATH 85.

MATH 1060 Precalculus II (4)
This course is the second half of the Precalculus Sequence. Topics include: trigonometric functions, analytic trigonometry, vectors, polar equations, parametric equations, conic sections, and applications. Prerequisite: Student must satisfy at least one of the following requirements: (1) C- or better from MATH 1050; or (2) Satisfaction of the Entry Level Mathematics requirement and a score of 65 or higher on the Math Placement Exam. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 190 or 191.

*All students who want to take a precalculus course for the first time in CSUB should take the *Math Placement Exam.*

MATH 1209 Statistics in the Modern World (3)
This course introduces statistical applications and reasoning to a diverse audience. The aim is to provide understanding of basic statistical principles rather than in depth coverage of statistical methods so that the student can understand research reports involving statistics and its applications reported in the media. Topics include: sampling, experimentation, data exploration, chance phenomena, and basic methods of statistical inference. The course will include many examples from the Humanities and Social Sciences. Use of statistical software. Prerequisite: (1) ELM score of 50 or higher, or (2) SAT (Math) score of 550 or higher, or (3) ACT (Math) score of 23 or higher, or (4) grade of C- or better in MATH 0920 or 0930. 150 minutes lecture/discussion per week. Note: (1) A grade of C- or better in this course satisfies the A4 General Education requirement. (2) Class may be taken concurrently with MATH 0920 or 0930. Not open to students with credit in MATH 2200. Quarter course prerequisites: D- or better in MATH 85. Satisfies general education requirement A4.

MATH 1300 Finite Mathematics (3)
Mathematics for business and social sciences. Topics selected from set theory, combinatorics, probability, statistics, systems of equations, matrix algebra, linear programming, Markov chains, graph theory, and mathematics of finance. Prerequisite: Student must satisfy at least one of the following requirements: (1) ELM score of 50 or higher, or (2) SAT (Math) score of 550 or higher, or (3) ACT (Math) score of 23 or higher, or (4) C- or better in MATH 0930. 150 minutes lecture/discussion per week. Quarter course prerequisites: D- or better in MATH 85.

MATH 2010 Calculus for the Biological and Chemical Sciences I (4)
Introduction to differential calculus with emphasis on limiting behavior. Topics include: discrete time models, sequences and difference equations with applications in the life sciences, optimization, and stability. Trigonometry is addressed throughout the course. This course makes use of technology. It is designed for the life sciences and is not intended for students in the engineering, physical or mathematical sciences. Prerequisites: Student must satisfy at least one of the following requirements: (1) A grade of C- or better in MATH 1040 or 1050; or (2) Satisfaction of the Entry Level Mathematics requirement and a score of at least 70 on the *Math Placement Exam*. Note: this course is not a prerequisite for MATH 2320 or 2520. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 190 or 191.

MATH 2020 Calculus for the Biological and Chemical Sciences II (4)
Introduction to integral calculus, differential equations, and multivariable calculus. Topics from integral calculus include: accumulation, signed area, the Fundamental Theorem of Calculus, computational methods, use of tables, numerical approximations, antiderivatives, techniques of integration, and applications of the integral such as area, volume, mean values. Topics from differential equations include: modeling, algebraic and graphical solutions, slope fields, numerical software and analytic solutions. Topics from multivariable calculus include: graphs, partial derivatives, the chain rule, optimization. This course makes use of technology. It is designed for the life sciences and is not intended for students in engineering, physics or the mathematical sciences. Prerequisite: C- or better in MATH 2010. Not open to students with credit in MATH 2310 or 2510. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 211.

MATH 2120 Number Systems and Algebraic Thinking for Preservice Elementary Teachers (5)
First of two courses intended to provide preservice elementary school teachers the deep understanding of K–8 mathematics that is required to be effective teachers. It includes the examination of the mathematics in the Number and Algebra strands of California's Common Core State Standards for Mathematics. It is a mathematics content course that models teaching techniques that promote exploration, discussion and conceptual understanding as described in California's Standards for Mathematical Practice and Mathematics Framework. Students are required to think beyond how to get answers and also consider the multiple ways young students may think about the concepts and make sense of the mathematics. The use of manipulatives is a major component of the course. Prerequisite: Student must satisfy at least one of the following requirements (1) ELM score of 50 or higher, or (2) SAT (Math) score of 550 or higher, or (3) ACT (Math) score of 23 or higher, or (4) a score of 3, 4, or 5 on any of the AP Statistics, AP AB Calculus, or AP BC Calculus exams or (5) a score of at least 60 on the *Math Placement Exam* or (6) C- or better in MATH 0930. 250 minutes lecture/discussion per week. Quarter course prerequisite: D- or better in MATH 85.

MATH 2200 Introduction to Statistical Concepts and Methods (4)
This course is an introduction to statistical methods which stresses the development of critical thinking skills and increased awareness of how these methods are applied in a variety of disciplines. It is designed to give students a foundation for further study of statistics. Topics include: descriptive statistics, sampling and experimentation, confidence intervals, two-sample hypothesis tests for means, topics in categorical data analysis, and simple linear regression. Additional topics may include one way and two-way ANOVA for completely randomized designs. This course will emphasize the statistical reasoning underlying the methods and make use of the program R. Prerequisite: Student must satisfy at least one of the following requirements: (1) ELM score of 50 or higher, or (2) SAT (Math) score of 550 or higher, or (3) ACT (Math) score of 23 or higher, or (4) C- or better in MATH 0930. 200 minutes lecture/discussion per week. Quarter course prerequisites: D- or better in MATH 85.

MATH 2310 Single Variable Calculus I for Engineers (4)
A first course in single variable calculus. Topics include: Definition and computation of limits using numerical, graphical, and algebraic approaches; Continuity and differentiability of functions; Derivative as a limit; Interpretation of the derivative as: slope of tangent line, a rate of change; Differentiation formulas: constants, power rule, product rule, quotient rule and chain rule; Derivatives of transcendental functions such as trigonometric, exponential or logarithmic; Implicit differentiation with applications, and differentiation of inverse functions; Higher-order derivatives; Graphing functions using first and second derivatives, concavity and asymptotes; Indeterminate forms and L'Hopital's Rule; Maximum and minimum values, and optimization; Mean Value Theorem; Antiderivatives and indefinite integrals; Area under a curve; Definite integral; Riemann sum; Properties of the integral; Fundamental Theorem of Calculus; Integration by substitution. Course makes use of a Computer Algebra System, and includes problem solving with a focus on engineering applications. Prerequisite: (1) C- or better in MATH 1040 or MATH 1060; or (2) Satisfaction of the Entry Level Mathematics requirement and a score of at least 80 on the *ALEKS PPL Math Placement Exam*. Note: Students without recent credit in MATH 1040 or MATH 1060 are advised to consult the Department of Mathematics and to take the *ALEKS PPL Math Placement Exam* before enrolling. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 192.

MATH 2320 Single Variable Calculus II for Engineers (4)
A second course of single variable calculus, sequences and series. Topics include: Areas between curves; Volume of a solid of revolution; Additional techniques of integration including integration by parts and trigonometric substitution; Numerical integration such as trapezoidal and Simpson's rule; Improper integrals; Applications of integration to areas and volumes; Additional applications of integration such as work, arc length, area of a surface of revolution, moments and centers of mass; direction field and Euler's method; Separable differential equations; Exponential growth and decay; Introduction to sequences and series; Multiple tests for convergence of sequences and series; Power series, radius of convergence, interval of convergence; Differentiation and integration of power series; Taylor series expansion of functions; Parametric equations and calculus with parametric curves; Polar curves and calculus in polar coordinates. Course makes use of a Computer Algebra System, and includes problem solving with a focus on engineering applications. Prerequisite: (1) C- or better in one of MATH 2310 or MATH 2510. Note: Not open to students with credit in MATH 2010. 200 minutes lecture/discussion per week.

MATH 2330 Multivariable and Vector Calculus for Engineers (4)
Topics include: Vectors and vector operations in two and three dimensions; Vector and parametric equations of lines and planes; Rectangular equation of a plane; Dot, cross, and triple products and projections; Differentiability and differentiation including partial derivatives, chain rule, higher-order derivatives, directional derivatives, and the gradient; Arc length and curvature, tangent, normal, binormal vectors; Vector-valued functions and their derivatives and integrals; Finding velocity and acceleration; Real-valued functions of several variables, level curves and surfaces; Limits, continuity, and properties of limits and continuity; Local and global maxima and minima extrema, saddle points, and Lagrange multipliers; Vector fields including the gradient vector field and conservative fields; Double and triple integrals; Applications of multiple integration such as area, volume,

center of mass, or moments of inertia; Change of variables theorem; Integrals in polar, cylindrical, and spherical coordinates. Line and surface integrals including parametrically defined surfaces; Integrals of real-valued functions over surfaces; Divergence and curl; Green's, Stokes', and divergence theorems. Course makes use of a Computer Algebra System, and includes problem solving with a focus on engineering applications. Prerequisite: C- or better in MATH 2320, or MATH 2520. Note: Not open to students with credit in MATH 2020. 200 minutes lecture/discussion per week.

MATH 2510 Single Variable Calculus I (4)
A first course in single variable calculus. Topics include: Definition and computation of limits using numerical, graphical, and algebraic approaches; Continuity and differentiability of functions; Derivative as a limit; Interpretation of the derivative as: slope of tangent line, a rate of change; Differentiation formulas: constants, power rule, product rule, quotient rule and chain rule; Derivatives of transcendental functions such as trigonometric, exponential or logarithmic; Implicit differentiation with applications, and differentiation of inverse functions; Higher-order derivatives; Graphing functions using first and second derivatives, concavity and asymptotes; Indeterminate forms and L'Hopital's Rule; Maximum and minimum values, and optimization; Mean Value Theorem; Antiderivatives and indefinite integrals; Area under a curve; Definite integral; Riemann sum; Properties of the integral; Fundamental Theorem of Calculus; Integration by substitution. Course makes use of a Computer Algebra System. Prerequisite: (1) C- or better in MATH 1040 or MATH 1060; or (2) Satisfaction of the Entry Level Mathematics requirement and a score of at least 80 on the ALEKS PPL Math Placement Exam. Note: Students without recent credit in MATH 1040 or MATH 1060 are advised to consult the Department of Mathematics and to take the *ALEKS PPL Math Placement Exam* before enrolling. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 192.

MATH 2520 Single Variable Calculus II (4)
A second course of single variable calculus, sequences and series. Topics include: Areas between curves; Volume of a solid of revolution; Additional techniques of integration including integration by parts and trigonometric substitution; Numerical integration such as trapezoidal and Simpson's rule; Improper integrals; Applications of integration to areas and volumes; Additional applications of integration such as work, arc length, area of a surface of revolution, moments and centers of mass; direction field and Euler's method; Separable differential equations; Exponential growth and decay; Introduction to sequences and series; Multiple tests for convergence of sequences and series; Power series, radius of convergence, interval of convergence; Differentiation and integration of power series; Taylor series expansion of functions; Parametric equations and calculus with parametric curves; Polar curves and calculus in polar coordinates. Course makes use of a Computer Algebra System. Prerequisite: (1) C- or better in one of MATH 2310 or MATH 2510. Note: Not open to students with credit in MATH 2010. 200 minutes lecture/discussion per week.

MATH 2530 Multivariable and Vector Calculus (4)
Topics include: Vectors and vector operations in two and three dimensions; Vector and parametric equations of lines and planes; Rectangular equation of a plane; Dot, cross, and triple products and projections; Differentiability and differentiation including partial derivatives, chain rule, higher-order derivatives, directional derivatives, and the gradient; Arc length and curvature, tangent, normal, binormal vectors; Vector-valued functions and their derivatives and integrals; Finding velocity and acceleration; Real-valued functions of several variables, level curves and surfaces; Limits, continuity, and properties of limits and continuity; Local and global maxima and minima extrema, saddle points, and Lagrange multipliers; Vector fields including the gradient vector field and conservative fields; Double and triple integrals; Applications of multiple integration such as area, volume, center of mass, or moments of inertia; Change of variables theorem; Integrals in polar, cylindrical, and spherical coordinates; Line and surface integrals including parametrically defined surfaces; Integrals of real-valued functions over surfaces; Divergence and curl; Green's, Stokes', and divergence theorems. Course makes use of a Computer Algebra System. Prerequisite: C- or better in MATH 2320, or MATH 2520. Note: This course is equivalent to MATH 2531 and MATH 2532 combined. Not open to students with credit in MATH 2020. 200 minutes lecture/discussion per week.

MATH 2531 Multivariable Calculus (4)
Topics include: Vectors and vector operations in two and three dimensions; Vector and parametric equations of lines and planes; Rectangular equation of a plane; Dot, cross, and triple products and projections; Differentiability and differentiation including partial derivatives, chain rule, higher-order derivatives, directional derivatives, and the gradient; Arc length and curvature, tangent, normal, binormal vectors; Vector-valued functions and their derivatives and integrals; Finding velocity and acceleration; Real-valued functions of several variables, level curves and surfaces; Limits, continuity, and properties of limits and continuity; Local and global maxima and minima extrema, saddle points, and Lagrange multipliers; Vector fields including the gradient vector field and conservative fields; Double and triple integrals; Applications of multiple integration such as area, volume, center of mass, or moments of inertia; Change of variables theorem; Integrals in polar, cylindrical, and spherical coordinates. Course makes use of a Computer Algebra System. Prerequisite: C- or better in MATH 2320, or MATH 2520. Note: Not open to students with credit in MATH 2020. 200 minutes lecture/discussion per week.

MATH 2532 Vector Calculus (2)
Topics include: Line and surface integrals including parametrically defined surfaces; Integrals of real-valued functions over surfaces; Divergence and curl; Green's, Stokes', and divergence theorems. Course makes use of a Computer Algebra System. Prerequisite: C- or better in MATH 2330. Note: MATH 2530 is equivalent to MATH 2531 and MATH 2532 combined. 100 minutes lecture/discussion per week.

MATH 2540 Ordinary Differential Equations (4)
Topic include: first order and linear differential equations, linear systems, Laplace transforms, numerical methods, and linear and nonlinear models with a geometrical and numerical approach to solutions and to questions of stability. Prerequisite: Student must satisfy the following requirements: (1) C- or better in MATH 2020 or 2320 or 2520 and (2) C- or better in CMPS 2010. 200 minutes lecture/discussion per week. Quarter course prerequisites: Student must satisfy the following requirements: (1) C- or better in MATH 203 and (2) C- or better in CMPS 221 or MATH 222 or ENGR 162.

MATH 2610 Linear Algebra I (4)
Topics include: matrices and systems of linear equations, linear independence, spanning sets, dimension, invertible matrices, determinants, column space, row space, null space, bases, and change of basis. Introduction to linear transformations, vector spaces, subspaces, eigenvalues, eigenvectors, and diagonalization. Appropriate technology will be utilized. Prerequisite: Student must satisfy the following requirements: C- or better in MATH 1060 or MATH 1040. 200 minutes lecture/discussion per week. Quarter course prerequisites: Student must satisfy the following requirements: C- or better in MATH 192.

MATH 2770 Special Topics in Mathematics (1-4)
Topics and prerequisites to be announced. May be repeated for different topics.

MATH 2771 Problem Solving (1)
Course reinforces topics from precalculus, calculus or mathematics for prospective elementary teachers. Students work on problems related to the mathematics class in which they are concurrently enrolled with the help of a facilitator. Corequisite: Any Precalculus, Calculus or Mathematics for Prospective Elementary Teachers course. CR/NC only.

Upper Division

MATH 3000 Mathematical Foundations (4)
Investigation of the fundamental tools used in writing mathematical proofs. Topics include: sentential and predicate calculus, topics from naive set theory, Cartesian products, partitions, equivalence relations, functions, countability, recursion, the binomial theorem and mathematical induction. This course relies heavily on problem solving and writing complete, logically consistent arguments to illustrate the correct use of the logical tools and methods discussed. Prerequisite: C- or better in MATH 1060 or 1040. 200 minutes lecture/discussion. Quarter course prerequisites: C- or better in MATH 192.

MATH 3100 Classical Algebra Connections (1)
The course consists of weekly seminar discussions to focus on connections between university mathematics and the mathematics that prospective secondary mathematics teachers will be teaching and as described in California's Common Core State Standards for Mathematics, Standards for Mathematical Practice, and Mathematics Framework. Course includes 45 hours of observation in middle or high schools. Observations will include opportunities for prospective teachers to interact with middle/high school students in small group instructional settings. Prerequisite or corequisite: Any upper division Mathematics major course. CR/NC 50 minutes lecture/discussion

MATH 3120 Geometry, Probability and Statistics for Preservice Elementary Teachers (5)
Second of two courses intended to provide preservice elementary school teachers the deep understanding of K–8 mathematics that is required to be effective teachers. It includes the examination of the mathematics in the Geometry, Probability, and Statistics strands of California's Common Core State Standards for Mathematics. It is a mathematics content course that models teaching techniques that promote exploration, discussion and conceptual understanding as described in California's Standards for Mathematical Practice and Mathematics Framework. Students are required to think beyond how to get answers and also consider the multiple ways young students may think about the concepts and make sense of the mathematics. The use of manipulatives is a major component of the course. Prerequisite: C- or better in MATH 2120. 250 minutes lecture/discussion per week.

MATH 3130 Geometry, Measurement, and Fractions for the Middle Grades (4)
Topics include: similarity, dilations, equivalent fractions, factors and multiples, proofs of the Pythagorean Theorem, rigid motions, and two dimensional representations of solids. Use of technology and manipulative materials as they relate to the middle grades curriculum. Prerequisite: (1) C- or better in MATH 3120, or (2) post-baccalaureate standing and permission of the instructor. 200 minutes lecture/discussion per week.

MATH 3140 Statistics, Data Analysis, and Mathematical Modeling for the Middle Grades (4)
Topics include: surveys and experiments, graphical representations of univariate and bivariate data, measures of central tendency and dispersion, and discrete, linear, quadratic, and exponential models for physical, biological and social phenomena. Use of technology and manipulative materials as they relate to the middle grades curriculum. Prerequisites: (1) C- or better in MATH 2200 and 3120, or (2) post-baccalaureate

standing and permission of the Instructor. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 140 and 321.

MATH 3150 Focus on Algebra for the Middle Grades (4)
Topics include: patterns and formulas; verbal, tabular, graphical, and symbolic representations of numerical and functional relations; and multiple approaches to word problems. Use of technology and manipulative materials as they relate to the middle grades curriculum. Prerequisites: (1) C- or better in MATH 1040 or 1060, and in MATH 3120, or (2) post-baccalaureate standing and permission of the Instructor. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 192 and 321.

MATH 3200 Probability Theory (4)
Topics include: basic probability theory, combinatorial methods, independence, conditional and marginal probability, probability models for random phenomena, random variables, probability distributions, distributions of functions of random variables, mathematical expectation, covariance and correlation, conditional expectation, asymptotic distributions, and sampling distributions. The course makes use of the statistical program R to evaluate and graph probability models and distribution functions, and to simulate realizations of random variables. Prerequisites: C- or better in MATH 2320 or 2520. Recommended MATH 2330 or 2530. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 203.

MATH 3210 Applied Statistical Computing and Multivariate Methods (4)
Introduction to common applied multivariate statistical methods that provide inferences about several variables from a population. Use of statistical software to motivate understanding of a wide variety of issues related to the management of data in today's data centric world. Essential programming concepts include: typical data processing tasks, data manipulation, looping structures, conditional execution, and data management techniques. Statistical analyses include: high-dimensional data visualization, matrix algebra notation and literacy, principal components and factor analysis, and discriminant and classification analysis. Additional topics may include clustering, LaTeX, or special topics selected by instructor. Use of R and SAS throughout the course. No previous programming experience required. Prerequisite: C- or better in MATH 2200. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 140.

MATH/CMPS 3300 Numerical Analysis (4)
Topics include: computer representation of numbers and round-off errors, algorithms and stability, numerical solutions to nonlinear equations in one variable, direct and iterative methods for solving linear systems of equations, interpolation and polynomial approximation, numerical differentiation and integration, and initial value problems for ordinary differential equations. A computer algebra system (CAS) will be used to program numerical algorithms and identify their limitations. Numerical software will be used. Prerequisites: (1) C- or better in MATH 2020, 2320, or 2520, and (2) C- or better in MATH 2610 or CMPS 2010. 200 minutes lecture/discussion per week. Quarter course prerequisites: Student must satisfy the following requirements: (1) C- or better in MATH 203 and (2) C- or better in MATH 230, 330, CMPS 221 or MATH 222 or ENGR 162.

MATH 3310 Discrete Mathematical Modeling (4)
Introduction to mathematical modeling using graph theory. Topics include: graphs, subgraphs, paths, cycles, regular and bipartite graphs, Eulerian and Hamiltonian graphs, digraphs, matrices associated to graphs, trees, spanning trees, rooted trees, path algorithms and connectivity, vertex and edge colorings. Applications include social networks, internet search engines, chemistry, ecology, archaeology, genetics, telecommunication networks, dynamical systems, the traveling salesman problem, and others depending on the instructor. Prerequisite: C- or better in MATH 2610, and 3000. 200 minutes lecture/discussion per week. Quarter course prerequisites: (1) C- or better in MATH 230 or 330 and (2) C- or better in MATH 300.

MATH 3400 Euclidean Geometry (4)
The course begins with a thorough review of high school geometry, then goes on to discuss special points associated with triangles, circles and certain associated lines, Ceva's Theorem, and compass-and-straightedge constructions. There is emphasis on providing numerical formulas like the laws of sines, cosines, and tangents, Stewart's theorem, Ptolemy's theorem and the area formula of Heron. Dynamical Geometry software is used for exploration and discovery. This course provides a survey of material needed to prepare students to teach high school geometry courses. Prerequisites: C- or better in MATH 3000. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 300.

MATH 3500 Complex Variables (4)
Topics include: complex numbers, analytic functions, conformal mapping, integrals, Cauchy's Theorem and the calculus of residues, and power series. Prerequisite: C- or better in MATH 2020, 2320, or 2520. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 203.

MATH 3520 Analysis I (4)
Introduction to Real Analysis. Topics include: cardinality, sequences and series, limits, and continuous functions. Additional topics may include: differentiation and the Riemann Integral. Prerequisites: Student must satisfy the following requirements: (1) C- or better in MATH 2320 or 2520, and (2) C- or better in MATH 3000. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 203 and 300.

MATH 3600 Modern Algebra (4)
A study of the classical algebraic structures in mathematics. Number theory topics include: divisibility theory, induction and well ordering, Euclidean Algorithm, linear Diophantine equations, continued fractions, Euclid's Lemma and unique prime factorization of positive integers, modular arithmetic, and theorems of Euler and Fermat. Abstract Algebra topics include: groups (Zn, Un, Cyclic and Dihedral Groups, Frieze Groups, isometries of the plane, homomorphisms, subgroups, and quotient groups), rings (Z, Zm, Q[x], and matrices), domains (integral and Euclidean), fields (Q, R, C, and Zp), ordered fields, subfields of C, and solutions of polynomials over R and C. Prerequisites: C- or better in both MATH 2610 and 3000. 200 minutes lecture/discussion per week. Quarter course prerequisites: (1) C- or better in MATH 230 or 330 and (2) C- or better in MATH 300.

MATH 3620 Abstract Algebra I (4)
Introduction to binary operations and basic axiomatic algebraic structures. Topics include: groups, rings, integral domains, and fields. Prerequisites: C- or better in both MATH 2610 and 3000. 200 minutes lecture/discussion per week. Quarter course prerequisites: (1) C- or better in MATH 230 or 330 and (2) C- or better in MATH 300.

MATH 4110 Introduction to the History of Mathematics (4)
A survey of the history of mathematics from antiquity to the present. Topics include: modes of computation, the development of the idea of proof, the "analytical method" of algebra, and the invention of the calculus. Prerequisites: Student must satisfy both of the following requirements: (1) C- or better in at least three upper division mathematics major courses one of which must be MATH 3000, and (2) Satisfaction of the CSU Graduation Writing Assessment Requirement (GWAR). 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in at least three upper division mathematics major courses one of which must be MATH 300.

MATH 4120 Modern Mathematics for Teachers (4)
The goal of the course is to cultivate a deeper understanding of grades 6 - 12 mathematics. It is a mathematics content course that models teaching techniques that promote exploration, discussion and conceptual understanding through the use of computer-based technology and manipulatives that *may* include, but not be limited to, fraction bars, algebra tiles and Cuisenaire rods. Students will make presentations on mathematics appropriate in California's middle school and high school classrooms and that emphasize active learning and sense-making consistent with California's Common Core State Standards, Standards for Mathematical Practice, and Mathematics Framework. Prerequisite: C- or better in at least four upper division mathematics major courses from the Teaching Concentration, including MATH 3000. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in at least four upper division mathematics major courses one of which must be MATH 300.

MATH 4200 Mathematical Statistics (4)
This course provides an introduction to the fundamentals of statistical inference using advanced mathematical concepts and techniques for a deeper understanding of topics in estimation, confidence intervals, hypothesis testing, and basic Bayesian methods. Topics and activities include distribution of sample statistics; t, chi-squared and F distributions; estimation theory that covers sufficiency, efficiency, consistency, method of moments, maximum likelihood; hypothesis and Bayesian testing; likelihood ratio test; confidence and credible intervals; prior and posterior distributions; inference using large data sets with R; simulation aspects of topics in inference with R. Other topics may include linear models and analysis of categorical data. Prerequisite: C- or better in MATH 3200. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 340.

MATH 4210 Regression Modeling and Analysis (4)
Advanced course in applied regression analysis. Topics include: linear regression, randomization tests for linear regression, correlation analysis, model diagnostics, matrix algebra notation and literacy for developing concepts of linear regression, variable and model selection techniques. Additional topics may include logistic regression, path analysis, forecasting, and special topics selected by instructor. Use of R or SAS throughout the course. Prerequisites: C- or better in MATH 2200 or 4200. Recommended: MATH 3210. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 140 and 420.

MATH 4220 Design and Analysis of Experiments (4)
Statistical principles and concepts in the design and analysis of experiments. Topics include: fixed and random effects models, expected mean squares, multiple comparisons, nonparametric methods, basic designs including completely randomized design, randomized blocks design, incomplete block designs, Latin squares, factorial designs, and nested designs. Use of R or SAS throughout the course. Prerequisite: C- or better in MATH 2200 or 4200. Recommended: MATH 3210. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 140 and 420.

MATH/CMPS 4300 Applied Cryptography (4)
An introduction to cryptography, history and its present day use. Topics include: symmetric ciphers, hash functions, public-key encryption, data integrity, digital signatures, key establishment, key management, prime generation, integer factorization, discrete logarithms, pseudo-random number generation, and computational complexity. Cross-listed as CMPS 4300. Prerequisites: (1) C- or better in MATH 2020, 2320, or 2520, and (2) C- or better in MATH 3000 or CMPS 2120. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 203 and 300.

MATH 4500 Partial Differential Equations (4)
Topics include: first order linear partial differential equations (PDEs), the method of characteristics, Cauchy Problems, Fourier Series, boundary value problems of second order PDEs from mathematical physics, orthogonal functions and generalized Fourier series, Sturm-Liouville problems, and numerical solutions. Additional topics may include: harmonic functions, Green functions, Fourier transforms, or calculus of variations. Prerequisites: C- or better in MATH 2530 and 2540. 200 minutes lecture/discussion per week. Quarter course prerequisites: C- or better in MATH 204 and 205.

MATH 4520 Analysis II (4)
A continuation of Analysis I. Topics may include: the topology of the real line, Lebesgue measure, nonmeasurable sets, Lebesgue measurable functions, Lebesgue integration, uniform integrability, and a rigorous foundation of sequences and series of functions, normed linear spaces, and Hilbert space. Prerequisites: C- or better in MATH 3520. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 363.

MATH 4600 Number Theory (4)
Elementary theory of the natural numbers. Topics include: prime numbers and divisibility, congruences, number theoretic functions, Diophantine equations, and selected topics. Prerequisites: C- or better in MATH 3000. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 300.

MATH 4610 Linear Algebra II (4)
Continuation of Linear Algebra I. Topics include: vector spaces, subspaces, bases, dimension, linear transformations, rank, nullspace, determinants, eigenvalues and eigenvectors, diagonalization, inner product spaces, Gram-Schmidt process, adjoints, normal and self-adjoint operators, unitary and orthogonal operators, the Spectral Theorem, bilinear and quadratic forms, Jordan and rational canonical forms. Prerequisites: (1) C- or better in MATH 2020, 2320, or 2520, and (2) C- or better in MATH 2610 and 3000. 200 minutes lecture/discussion per week. Quarter course prerequisite: (1) C- or better in MATH 204 and 205 and (2) C- or better in MATH 230 or 330 and (3) C- or better in MATH 300.

MATH 4620 Abstract Algebra II (4)
Continuation of Abstract Algebra I. Topics include: Sylow Theorems, Galois Theory, and selected topics. Prerequisites: C- or better in MATH 3620. 200 minutes lecture/discussion per week. Quarter course prerequisite: C- or better in MATH 331.

MATH 4770 Special Topics in Mathematics (1-4)
Topics and prerequisites to be announced. This course can be used in the Mathematics Major only to satisfy elective requirements. Permission of instructor required.

MATH 4800 Research Participation (1-4)
Supervised mathematical investigation. May be repeated. Offered on a credit, no credit basis only. Prerequisite: Permission of instructor.

MATH 4850 Senior Honors Thesis (4)
Individual study with a faculty advisor leading to a formal written report on a specific topic or problem. Prerequisites: (1) Senior standing, (2) consent of faculty advisor, and (3) approval of the Chair of the Department of Mathematics. 200 minutes lecture/discussion per week.

MATH 4860 Internship in Mathematics (1-4)
Internships may be arranged by the department with various agencies, businesses, or industries. The assignments and coordination of work projects with conferences and readings, as well as course credits, evaluation, and grading, are the responsibility of the faculty liaison, or course instructor, working with the field supervisor. Open only to matriculated students eligible to work on campus as tutors under the supervision of the Department of Mathematics. Class does not count towards the mathematics major. Not open to post-graduate mathematics students. Offered on a credit, no-credit basis only. Prerequisite: 2.0 GPA minimum.

MATH 4908 Senior Seminar (4)
Students in this capstone course will make presentations on, write papers about, and discover and discuss solutions of mathematical problems from varied areas of mathematics. Prerequisites: (1) C- or better in at least four upper division courses from the Applied, Pure, or Statistics Concentrations; and (2) Satisfaction of the CSUB Graduation Writing Assessment Requirement (GWAR). 200 minutes lecture/discussion per week.

MATH 4910 Senior Seminar in Mathematics for Prospective Teachers (4)
Students in this capstone course will make presentations on, write papers about, and discuss solutions of mathematical problems grounded in secondary school mathematics education. The focus is mathematics as described in California's Common Core State Standards, Standards for Mathematical Practice, and Mathematics Framework with appropriate inclusion of pedagogical ideas. Prerequisites: (1) C- or better in at least four upper division mathematics major courses from the Teaching Concentration; and (2) Satisfaction of CSUB Graduation Writing Assessment Requirement (GWAR). 200 minutes lecture/discussion per week.