***Developmental Mathematics***

**MATH 75 Developmental Mathematics I (5)**

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 36 or below on the ELM. Co-requisite: GST 75. Enrollment in this course if the CSU Entry Level Mathematics requirement has been satisfied requires instructor permission.

**MATH 85 Developmental Mathematics II (5)**

Second of two courses reviewing fundamental concepts, geometry, basic data analysis, and introductory algebra. Topics include: Functions; algebra of polynomial rational and radical expressions; factoring; introduction to rational exponents; solutions of linear, systems of linear, absolute value, quadratic, rational and radical equations; solutions of linear inequalities in two variables; graphs of quadratic functions; midpoint and distance formulas; ratio, proportion and similar triangles; square and higher-order roots. Emphasis is on applications of concepts. Passing this course satisfies the Entry Level Mathematics requirement but does not count toward graduation. Prerequisite: (1) A score of 38 - 48 on the ELM; or (2) a passing grade in MATH 75. Co-requisite: GST 85. Enrollment in this course if the CSU Entry Level Mathematics requirement has been satisfied requires instructor permission.

***Lower Division***

To enroll in any course numbered 100 or above, a student must have satisfied the CSU Entry Level Mathematics requirement [see the section on Academic Information].

**MATH 101 Finite Mathematics (5)**

Mathematical topics for business, social, and life sciences selected from logic; set theory; combinatorics; statistics; matrix algebra; linear programming; Markov chains; analytic geometry; graph theory; and mathematics of finance. Prerequisite: Satisfaction of the CSU Entry Level Mathematics requirement.

**MATH 120 Introduction to Quantitative Methods in Business (5)**

Matrix algebra and systems of equations, analytic geometry, basic concepts of differential calculus and introduction to integral calculus. Applications from the areas of business and economics. Course makes use of appropriate computing technology and graphing utilities. Prerequisite: Satisfaction of the CSU Entry Level Mathematics requirement.

**MATH 140 Elementary Statistics (5)**

Descriptions of sample data; exploratory data analysis; elementary probability; binomial, normal, t-, and other distributions; estimation and hypothesis testing techniques; linear regression and correlation. Use of statistical packages. Applications to fields including business, natural sciences, social sciences, and humanities. Prerequisite: Satisfaction of the CSU Entry Level Mathematics requirement. (Credit toward graduation cannot be earned for both MATH 140 and PSYC 200) **GE B4**

**MATH 190 Pre-calculus I: Intermediate and College Algebra (7)**

Review of Intermediate Algebra including operations with polynomials and radicals, and absolute value. The algebraic and graphical analysis of polynomial, rational, exponential, and logarithmic functions and their applications. The concept of function is used as a unifying theme. This course makes use of graphing utilities. Prerequisite: Satisfaction of the CSU Entry Level Mathematics requirement. It is recommended that students enroll concurrently in MATH 281. **Note:** *Students whose previous intermediate algebra coursework is not recent are strongly encouraged to enroll in MATH 190. Students may receive credit for either MATH 190 or MATH 191, but not both.*

**MATH 191 Pre-calculus I: College Algebra (5)**

Algebraic and graphical analysis of polynomial, rational, logarithmic and exponential functions and their applications. The concept of function is used as a unifying theme. This course makes use of graphing utilities. Prerequisite: (1) Score of (a) 50 or higher on the ELM Exam, (b) 550 or higher in the SAT (Math) exam, or (c) 23 or higher in the ACT (Math) exam; or (2) Satisfaction of the CSU Entry Level Mathematics requirement and a passing score on the Pre-calculus Readiness Test. It is recommended that students enroll concurrently in MATH 281.

**MATH 192 Pre-calculus Mathematics II: Trigonometric Functions (5)**

Algebraic, geometric and graphical analysis of trigonometric functions and their applications. Unit circle trigonometry. Trigonometric functions of real numbers. Introduction to polar coordinates and conics. This course makes use of graphing utilities. Prerequisite: A grade of C- or better in MATH 190 or 191. It is recommended that students enroll concurrently in MATH 281.

**MATH 201 Calculus I (5)**

Introduction to the differential calculus of elementary (including logarithmic, exponential, and trigonometric) functions. Emphasis on limits, continuity, and differentiation. Applications of differentiation (including curve sketching, optimization, and related rates); antiderivatives. Students may not use any Computer Algebra System (CAS) capability in this course. Prerequisite: (1) A grade of C- or better in MATH 192; or (2) Satisfaction of the Entry Level Mathematics requirement and an appropriate score on the UC/CSU MDTP Calculus Readiness Test or equivalent. It is recommended that students enroll concurrently in MATH 281. **Note***: Students without recent credit in MATH 192 are advised to consult the Department of Mathematics and to take the UC/CSU Pre-calculus Diagnostic Test before enrolling in MATH 201.*

**MATH 202 Calculus II (5)**

Introduction to the integral calculus of elementary functions. The Fundamental Theorem of Calculus; techniques of integration; applications of integration; improper integrals**;** sequences and series. Students may not use any Computer Algebra System (CAS) capability in this course. Prerequisite: A grade of C- or better in MATH 201 or 231. It is recommended that student enrolls concurrently in MATH 281.

**MATH 203 Calculus III (5)**

Three dimensional analytic geometry; parametric curves; functions of several variables; partial and directional derivatives; the chain rule; gradients; optimization including Lagrange multipliers; double integrals**.** This course may make use of computer algebra systems. Prerequisite: A grade of C- or better in MATH 202, 212 or 232. It is recommended that student enrolls concurrently in MATH 281**.**

**MATH 204 Calculus IV (5)**

Polar, cylindrical and spherical coordinates; double integrals; triple integrals; vector calculus, including line and surface integrals, the Fundamental Theorem of Line Integrals, and the theorems of Green, Stokes, and Gauss; selected topics. This course may make use of computer algebra systems. Prerequisite: A grade of C- or better in MATH 203 or 233 and either MATH 222 or CMPS 221. It is recommended that student enrolls concurrently in MATH 281**.**

**MATH 205 Ordinary Differential Equations (5)**

First-order differential equations; linear differential equations; linear systems. Laplace transforms and/or series solutions of second-order linear equations; geometric approach to nonlinear differential equations and to questions of stability. Prerequisite: A grade of C- or better in MATH 203 or 233 and either MATH 222 or CMPS 221. It is recommended that student enrolls concurrently in MATH 281**.**

**MATH 211 Calculus for Life Sciences and Medicine I (5)**

Discrete time models, sequences and difference equations with applications in the life sciences. Introduction to differential calculus with emphasis on limiting behavior. Applications include optimization and stability. Trigonometry is addressed throughout the course. This course makes use of technology, and is designed for the life sciences; it is not intended for students in the engineering, physical or mathematical sciences. Course will not serve as prerequisite for MATH 202. Prerequisite: (1) A grade of C- or better in MATH 190 or 191; or (2) Satisfaction of the Entry Level Mathematics requirement and an appropriate score on the UC/CSU MDPT Calculus Readiness Test. It is recommended that students enroll concurrently in MATH 281.

**MATH 212 Calculus for Life Sciences and Medicine II (5)**

Introduction to the integral calculus of elementary functions. Integration techniques and computational methods; differential equations; equilibria and their stability. This course makes use of technology, and is designed for the life sciences; it is not intended for students in the engineering, physical or mathematical sciences. Not open to students with credit in MATH 201. Prerequisite: A grade of C- or better in MATH 211. It is recommended that students enroll concurrently in MATH 281.

**MATH 221 Introduction to Number Systems and Reasoning (5)**

Introduction to set theory, inductive and deductive reasoning including patterns and sequences. The development and structure of the real number system beginning with whole numbers, numeration systems, computational algorithms, number theory, estimation and uses of calculators in problem solving. The use of proportional reasoning in numerical and algebraic problems. This course involves substantial use of 2- and 3- dimensional concrete materials in a cooperative learning setting. Prerequisite: Satisfaction of the CSU Entry Level Mathematics Requirement.

**MATH 222 Laboratory Experience (3)**

Introduction to the use of a computer algebra system in exploring applications in mathematics. Prerequisite: A grade of C- or better in MATH 201.

**MATH 230 Linear Algebra and Its Applications (5)**

Matrices and systems of linear equations; Gaussian elimination and analysis; basic concepts of vector space, linear independence, bases, linear transformations particularly in R2 and R3; change of bases; inner products; orthogonality and orthonormal bases; eigenvalues and eigenvectors; diagonalization; matrix factorizations; complex numbers; applications of linear algebra. Course work includes the use of a computer algebra system. Prerequisite: MATH 203 or 233.

**MATH 231 Calculus I for Engineering Sciences (5)**

Introduction to the differential calculus of elementary (including logarithmic, exponential, and trigonometric) functions. Emphasis on limits, continuity, and differentiation. Applications of differentiation (including curve sketching, optimization, and related rates); antiderivatives. Applications to Engineering and Physics. Students may not use any Computer Algebra System (CAS) capability in this course. Prerequisite: (1) A grade of C- or better in MATH 192; or (2) Satisfaction of the Entry Level Mathematics requirement and an appropriate score on the UC/CSU MDTP Calculus Readiness Test or equivalent. It is recommended that students enroll concurrently in MATH 281. **Note**: Students without recent credit in MATH 192 are advised to consult the Department of Mathematics and to take the UC/CSU Pre-calculus Diagnostic Test before enrolling in MATH 231.

**MATH 232 Calculus II for Engineering Sciences (5)**

Introduction to the integral calculus of elementary functions. The Fundamental Theorem of Calculus; techniques of integration; applications of integration; improper integrals; sequences and series. Applications to Engineering and Physics. This course may make use of computer algebra systems. Prerequisite: A grade of C- or better in MATH 201 or 231. It is recommended that student enrolls concurrently in MATH 281.

**MATH 233 Calculus III for Engineering Sciences (5)**

Three dimensional analytic geometry; parametric curves; functions of several variables; partial and directional derivatives; the chain rule; gradients; optimization including Lagrange multipliers; double integrals. Applications to Engineering and Physics. This course may make use of computer algebra systems. Prerequisite: A grade of C- or better in MATH 202, 212 or 232. It is recommended that student enrolls concurrently in MATH 281.

**MATH 234 Calculus IV for Engineering Sciences (5)**

Polar, cylindrical and spherical coordinates; double integrals; triple integrals; vector calculus, including line and surface integrals, the Fundamental Theorem of Line Integrals, and the theorems of Green, Stokes, and Gauss; selected topics. Applications to Engineering and Physics. This course may make use of computer algebra systems. Prerequisite: A grade of C- or better in MATH 203 or 233 and either MATH 222 or CMPS 221. It is recommended that student enrolls concurrently in MATH 281.

**MATH 240 America Counts Tutor Training (1)**

Course provides CSUB America Counts tutors with the training required to participate in the America Counts Program. Prerequisite: Permission of instructor. Offered on a credit, no-credit basis.

**MATH 251 Focus on Algebra for Middle School Teachers (5)**

Patterns and Formulas. Verbal, Tabular, Graphical, and Symbolic Representations of Numerical Relations. Multiple Approaches to Word Problems. Geometric Models in Elementary Algebra. Activities and use of technology and manipulative materials as they relate to the middle grades curriculum. This course is designed for in-service middle school teachers of mathematics and is not ordinarily available to pre-service teachers. Prerequisite: Permission of the instructor.

**MATH 252 Geometry, Measurement, and Fractions for Middle School Teachers (5)**

Similarity, Equivalent Fractions, Factors and Multiples, Spatial Visualization, Perspective and other Two Dimensional Representations of Solids. Activities and use of technology and manipulative materials as they relate to the middle grades curriculum. This course is designed for in-service middle school teachers of mathematics and is not ordinarily available to pre-service teachers. Prerequisite: Permission of the instructor.

**MATH 253 Probability, Statistics, and Number Sense for Middle School Teachers (5)**

Elementary Probability, Area Models, Surveys, Bar Graphs, Fair and Unfair Games, Expected Value, Measures of Central Tendency and Dispersion. Number Sense and Problem Solving activities using patterns, formulas, tables, estimation and mental arithmetic, and other strategies. Activities and use of technology and manipulative materials as they relate to the middle grades curriculum. This course is designed for in-service middle school teachers of mathematics and is not ordinarily available to pre-service teachers. Prerequisite: Permission of the instructor.

**MATH 254 Algebraic Modeling for Middle School Teachers (5)**

Data Collection: Surveys and Experiments. Discrete, Linear, Quadratic and Exponential Models for Physical, Biological and Social Phenomena. Residual Analysis. Activities and use of technology and manipulative materials as they relate to the middle grades curriculum. This course is designed for in-service middle school teachers of mathematics and is not ordinarily available to pre-service teachers. Prerequisite: Permission of the instructor.

**MATH 277 Special Topics in Mathematics (1-5)**

Analysis of contemporary and interdisciplinary problems. Topics and prerequisites to be announced.

**MATH 281 Tutoring in Precalculus and Calculus (1)**

Course covers topics from precalculus and calculus. Students work on problems related to the mathematics class in which they are concurrently enrolled with the help of a facilitator. Co-requisite: Any course from MATH 190-212, and MATH 231-234 inclusive.

**MATH 289 Experiential Prior Learning (5)**

Evaluation and assessment of learning which has occurred as a result of prior off-campus experience relevant to the curriculum of the department. Requires complementary academic study and/or documentation. Available by petition only, on a credit, no credit basis. Not open to post-graduate mathematics students. Interested students should contact the Department of Mathematics.

***Upper Division***

**MATH 300 Sets and Logic (5)**

Investigation of the fundamental tools used in writing mathematical proofs, including 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: MATH 202, 212 or 232.

**MATH 301 Modern Algebra (5)**

Study of the basic algebraic systems of mathematics. Topics include integers, Euclidean Algorithm, modular arithmetic, rational, real, and complex numbers systems as fields, polynomial rings, and basic group theory. Prerequisite: MATH 300.

**MATH 301B Classical Algebra Connections (1)**

Weekly seminar discussions to focus on connections between university mathematics and the mathematics that prospective secondary mathematics teachers will be teaching. 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.

**MATH 302 Ordinary Differential Equations (5)**

First-order differential equations; linear differential equations; linear systems; Laplace transforms and/or series solutions of second-order linear equations; geometric approach to nonlinear differential equations and to questions of stability. Cross-listed as MATH 205. Prerequisite: A grade of C- or better in MATH 203 or 233 and either MATH 222 or CMPS 221.

**MATH 304 Calculus IV (5)**

Polar, cylindrical and spherical coordinates; double integrals; triple integrals; vector calculus, including line and surface integrals, the Fundamental Theorem of Line Integrals, and the theorems of Green, Stokes, and Gauss; selected topics. This course may make use of computer algebra systems. Cross-listed as MATH 204. Prerequisite: A grade of C- or better in MATH 203 or 233. Students without credit in MATH 222 or CMPS 222 are required to enroll in either concurrently.

**MATH 305 Numerical Analysis (5)**

Number representation and basic concepts of error; numerical solutions of nonlinear equations and systems of equations; interpolation and extrapolation; numerical differentiation and integration; numerical solutions of ordinary differential equations; approximation by spline functions. Prerequisites: CMPS 221 and MATH 203 or permission of instructor. Cross-listed with CMPS 305.

**MATH 312 Complex Variables (5)**

Complex numbers; analytic functions; conformal mapping; integrals; Cauchy’s Theorem and the calculus of residues; power series. Prerequisite: MATH 204 or 234.

**MATH 320 Number Systems, Statistics and Probability (5)**

Continuation of the development of the real numbers including applications and models of rational numbers, irrational numbers, percent, and proportional reasoning. Introduction to the basic notions of chance and probability. Introduction to data analysis and statistics. This course involves substantial use of 2- and 3-dimensional concrete materials in a cooperative learning setting. Prerequisites: A grade of C- or better in MATH 221.

**MATH 321 Introduction To Modern Geometry (5)**

Introduction to the geometry of plane and solid shapes. Networks and applications. Constructions, congruence, and similarity. Concepts of measurement. Motion geometry and tessellations. The use of calculators and/or dynamical geometry software in discovery and problem solving. This course involves substantial use of 2- and 3-dimensional concrete materials in a cooperative learning setting. Prerequisites: A grade of C- or better in MATH 221.

**MATH 330 Linear Algebra (5)**

Matrices and systems of linear equations; vector spaces, dimensions, linear independence; spaces associated with matrices; bases, change of basis, orthogonal bases; linear transformations, matrix representation; eigenvalues and eigenvectors, diagonalization; selected applications. Prerequisite: MATH 203 or 233 and either MATH 222 or CMPS 221. Prerequisite or co-requisite: MATH 300 or CMPS 295.

**MATH 331 Algebraic Structures I (5)**

Introduction to binary operations and algebraic structures; groups, rings, integral domains, and fields. Prerequisite: (1) MATH 300, and (2) MATH 330, which may be taken concurrently.

**MATH 338 Analysis of Variance and Experimental Design (5)**

Single-factor ANOVA; multiple comparisons; completely randomized design; fixed and random effects; two-factor ANOVA; randomized complete block design; Latin squares design, factorial models; fixed, random, and mixed models; nested models. Use of statistical packages. Prerequisite: MATH 140 or 440.

**MATH 339 Regression Analysis (5)**

Least squares; simple linear regression; correlation analysis; residual analysis; multiple regression; variable and model selection techniques; logistic regression. Use of statistical packages. Prerequisite: MATH 140 or 440**.**

**MATH 340 Probability Theory (5)**

Sample spaces and events; counting problems, permutations and combinations; conditional probability; independence; Bayes theorem; discrete and continuous random variables; bivariate, multivariate, marginal, and conditional distributions; functions of random variables; expected value, moments, variance, covariance, and correlation; distribution theory; central limit theorem. Prerequisite: MATH 203 or 233. Prerequisite or co-requisite: MATH 300 or CMPS 295.

**MATH 350 Introduction to Mathematical Modeling (5)**

Course designed to give the student an early introduction to the construction and use of empirical and analytic mathematical models from areas such as economics, game theory, integer programming, mathematical biology and mathematical physics (topics depend on instructor). Course evaluation will involve at least one extended project. Prerequisite: MATH 205.

**MATH 360 Euclidean Geometry (5)**

Elaboration of concepts in Euclidean geometry and 19th- and 20th-century expansions of Euclid’s work. Topics include concurrency of lines in a triangle, collinearity of some points in a triangle, symmetric points in a triangle, some properties of triangles and quadrilaterals, equicircles and the nine-point circle. Additional topics may be included. Ability to write formal synthetic and analytic proofs is stressed. 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: (1) MATH 300, and (2) MATH 330, which may be taken concurrently.

**MATH 363 Introduction to Analysis I (5)**

Development of a rigorous foundation for analysis; axioms for the real numbers; sequences and series; continuity; introduction to differentiability and integration. Prerequisites: (1) MATH 203 or 233, and (2) MATH 300.

**MATH 402 Partial Differential Equations (5)**

Fourier series; classical partial differential equations such as heat equation, wave equation, and Laplace equation; Sturm-Liouville problems; orthogonal functions; topics from Fourier transform or calculus of variation. Prerequisites: (1) MATH 204 or 234 and (2) MATH 205.

**MATH 415 Methods in Applied Statistics and Data Analysis (5)**

This course emphasizes rationales, applications, and interpretations of Statistics using advanced statistical software. Topics may include probability distributions, parametric/non-parametric confidence intervals and hypothesis testing, categorical data analysis, simple/multiple regression, analysis of variance, simulation methods, and special topics. Prerequisite: MATH 140 or 440.

**MATH 420 Foundations of Geometry (5)**

Study of the classical axiomatization of Euclidean geometry. Hilbert’s incidence, congruence, similarity, separation, betweenness and continuity axioms are discussed. Special attention is paid to the Parallel Postulate and its alternative formulations, with an introduction to non-Euclidean geometries. Prerequisite: MATH 300.

**MATH 425 Modern Mathematics for Teachers (5)**

Course intended for prospective teachers of middle and high school mathematics, and includes investigations relevant to the California Common Core State Standards for Mathematics from the areas of number theory, algebra, geometry, probability, and statistics. The course emphasizes problem solving and cooperative activities. Students are introduced to appropriate use of current mathematical technologies. Prerequisite: Successful completion of 30 quarter units of college mathematics and MATH 202 or 232.

**MATH 427 Mathematics Curriculum and Instruction for Secondary Teachers (5)**

The content is designed to acquaint the candidates with the pedagogical techniques, philosophies, and practices utilized by successful secondary mathematics teachers and required by the Teaching Performance Expectations as delineated in the Standards of Quality and Effectiveness for Teacher Preparation Programs. The course includes at least ten hours of field experience in a middle school or high school mathematics classroom. This course does not count toward a major or a minor in mathematics.

**MATH 430 Number Theory (5)**

Elementary theory of the natural numbers, including prime numbers and divisibility, congruences, number theoretic functions, Diophantine equations, and selected topics. Prerequisite: MATH 300 and either MATH 222 or CMPS 221.

**MATH 431 Algebraic Structures II (5)**

Continuation of MATH 331. Galois Theory and selected topics. Prerequisite: MATH 331.

**MATH 440 Mathematical Statistics (5)**

Statistical inference; prior and posterior distributions, Bayes estimation, maximum likelihood estimation, method of moments; derivation of sampling distributions and their properties; unbiased estimators, Fisher information; theory of confidence intervals and hypothesis testing; power, t-test and F-test; analysis of categorical data, goodness of fit and contingency tables; inference for linear statistical models. Prerequisites: MATH 340.

**MATH 450 Introduction to the History of Mathematics (5)**

Development of mathematics from its empirical origins to its present form. Prerequisites: (1) MATH 300; (2) At least two mathematics courses numbered above 300 satisfying the major; and (3) Completion of CSUB’s GWAR.

**MATH 463 Introduction to Analysis II (5)**

Continuation of MATH 363; this course extends the classical Riemann theory of integration that students are familiar with from Calculus, and covers a rigorous foundation of sequences and series of functions. In addition, some elementary topics in general topology and normed linear spaces may be included. Choice of topics depending on instructor. Prerequisite: MATH 363.

**MATH 475 Applied Cryptography (5)**

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. Related topics include prime generation, integer factorization, discrete logarithms, pseudo-random number generation and computational complexity. Cross-listed as CMPS 475. Prerequisite: CMPS 221, and one of CMPS 295 or MATH 300.

**MATH 477 Special Topics in Mathematics (1-5)**

Topics and prerequisites to be announced. It can be used in the Mathematics Major only to satisfy elective requirements. Permission of instructor required.

**MATH 480 Research Participation (1-5)**

Supervised mathematical investigation. May be repeated. Offered on a credit, no credit basis only. Prerequisite: Permission of instructor.

**MATH 489 Experiential Prior Learning (1-5)**

Evaluation and assessment of learning which has occurred as a result of prior off-campus experience relevant to the curriculum of the department. Requires complementary academic study and/or documentation. Available by petition only, on a credit, no-credit basis. Not open to post-graduate mathematics students. Interested students should contact the Department of Mathematics.

**MATH 490 Senior Seminar (5)**

Preparation of papers and discussion by faculty and students. Prerequisites: (1) At least four upper-division courses from the Applied, Statistics or Theoretical Concentrations; and (2) Completion of CSUB’s GWAR.

**MATH 491 Senior Seminar in Mathematics for Prospective Teachers (5)**

Students will make presentations on, write papers about, and discuss solutions of mathematical problems grounded in secondary school mathematics education. The focus is mathematics with appropriate inclusion of pedagogical ideas. Prerequisites: (1) At least four upper division courses from the Teaching Concentrations; and (2) Completion of CSUB’s GWAR.

**MATH 492 Senior Honors Thesis (5)**

Individual study with a faculty advisor leading to a formal written report on a specific topic or problem. Prerequisites: (1) Senior standing; and (2) consent of faculty advisor; and (3) approval of the Chair of the Department of Mathematics.

**MATH 494 Senior Seminar for Elementary/Middle School Mathematics Teachers (5)**

Students will make presentations on, write papers about, and discuss solutions of mathematical problems grounded in elementary and middle school mathematics education with special emphasis on middle school. The focus is mathematics with appropriate inclusion of pedagogical ideas. Appropriate uses of current mathematical technologies are discussed. Prerequisites: (1) MATH 320 (or the equivalent), (2) MATH 321 (or the equivalent), (3) any mathematics course which has MATH 190 or 191 as a prerequisite (may be taken concurrently) and (3) Completion of CSUB’s GWAR.

**MATH 496 Internship in Mathematics (1-5)**

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 497 Cooperative Education (1-5)**

Class offers a sponsored learning experience in a work setting, integrated with a field analysis seminar. The field experience is contracted by the Cooperative Education office on an individual basis, subject to approval by the department. The field experience, including the seminar and reading assignments, is supervised by the cooperative education coordinator and the faculty liaison (or course instructor), working with the field supervisor. Students are expected to enroll in the course for at least two quarters. The determination of course credits evaluation and grading is the responsibility of the departmental faculty. Offered on a credit, no credit basis only.

***Graduate Courses***

**Note:** All courses require graduate standing. Students who have not attained graduate standing and who are interested in enrolling in a graduate class are encouraged to consult with the instructor and/or members of the Mathematics Graduate Program Committee.

**MATH 520 Discrete Mathematical Models (5)**

Construction and analysis of difference models from physical, biological, social, and financial sciences. Cobweb analysis, convergence, stability and chaos in discrete dynamical systems. Phase plane analysis of systems of difference equations.

**MATH 521 Statistics and Data Analysis (5)**

Classical and non-parametric confidence intervals and hypothesis tests for means, proportions, linear and multiple regression, and analysis of variance. Techniques include graphical displays, transformations, outlier identification, smoothing, regression and robustness; use of statistical package. Prerequisite: Prior experience with statistical analysis at the level of MATH 140.

**MATH 522 Numerical Approach to Calculus and Differential Equations (5)**

Use of numerical and algebraic techniques to study change. The use of forward, back, and symmetric differences in data analysis. Divided differences as average rates of change and as approximations to instantaneous rate of change. Difference equations and Euler’s method as numerical approximations to differential equations. Riemannsums, midpoint, trapezoid and Simpson’s method to approximate accumulated change. Error analysis for numerical approximations. Prerequisite: MATH 300 or 520.

**MATH 523 Geometric Linear Algebra (5)**

Algebra and geometry of vectors in two and three dimensions. Complex numbers. Matrices as linear transformations of R2 and R3. Rigid motions in two and three dimensions, their classification and matrix representations: Theory and classification of conic sections. Theory of perspective. Prerequisite: MATH 300.

**MATH 524 Number Theory and Codes (5)**

Elementary theory of natural numbers, including prime numbers, divisibility, modular arithmetic, and Diophantine equations. Applications in cryptography such as Caesar ciphers and RSA cryptosystem. Additional topics selected by instructor. This course makes use of a significant amount of calculator or computer programming. Prerequisite: MATH 300.

**MATH 525 Dynamical Geometry (5)**

Investigations in the Euclidean geometry of two dimensions using dynamical software. Emphasis on exploration, conjecture and verification. Prerequisite: MATH 300 or equivalent experience with the role of proof in Mathematics.

**MATH 526 Introduction to the History of Mathematics (5)**

Development of mathematics from its empirical origins to its present form. Euclid’s Elements. Prerequisites: (1) MATH 300, and (2) at least two mathematics courses that require MATH 300 as a prerequisite.

**MATH 540 Introduction to Mathematics Education Research (5)**

Brief introduction to basic philosophies, key terms and generally accepted strategies of both quantitative and qualitative research, such as the criteria and procedures appropriate for establishing validity reliability, credibility, and trustworthiness. Understanding ethics, confidentiality, protection of human subjects, variables, sampling, and data collection. Major emphasis on being able to find, evaluate, and use research in math education.

**MATH 577 Advanced Topics in Mathematics (1-5)**

Topics and prerequisites to be announced. May be repeated for different topics. General prerequisite: Major or minor in Mathematics.

**MATH 580 Advanced Research Participation (1-5)**

Individual mathematical investigation, under supervision. (Experience as a research assistant does not count for credit.) Offered on a credit/no credit basis only. Prerequisite: Permission of instructor.

**MATH 591 Culminating Project (5)**

Design and implementation of a written report of mathematical, or field research or similar activity. Prerequisites: Successful completion of 30 approved credits towards the Master of Arts in Mathematics for Teachers. Appointment of a Culminating Activity Committee consisting of three faculty members approved by the Mathematics Graduate Program Committee.