ACADEMIC SENATE
CSU BAKERSFIELD

Minor in Applied Mathematics

RES 252611

AAC, BPC

RESOLVED: That the Academic Senate approves the proposed new minor in Applied Mathematics.

RATIONALE: The minor in Applied Mathematics offers students a minor pathway in mathematics that does not require MATH 3000. The existing program resources are sufficient to support this new minor pathway.

Distribution List:

President
Provost and VP for Academic Affairs
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Department Chairs
General Faculty

Approved by the Academic Senate:
Sent to the President:
President Approved:

Academic Senate
California State University, Bakersfield
9001 Stockdale Hwy. • 22 EDUC • Bakersfield, CA 93311

661.654.3128 *csub.edu/senate*

ACADEMIC SENATE
CSU BAKERSFIELD

2025-2026 REFERRAL #09
Proposal for New Minor in Applied Mathematics

Date: September 4, 2025

From: Melissa Danforth, Academic Senate Chair

To: Tiffany Tsantsoulas, Academic Affairs Committee (AAC) Chair
Amanda Grombly, Budget and Planning Committee (BPC) Chair

cc: Katherine Van Grinsven, Academic Senate Administrative Analyst

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At their meeting on August 26, 2025, the Academic Senate Executive Committee requested that the Academic Affairs Committee (AAC) and Budget and Planning Committee (BPC) review and address the Proposal for New Minor in Applied Mathematics.

During your discussion, please consider:

- rationale as presented in the attached proposal
- impact on any students in the program.

Please take up this matter with your committee and get back to me with your recommendation. If your recommendation requires Senate action, please prepare a resolution and the rationale for the resolution.

Thank you.

Attachments: (1) NSME CC Approved_NEW Minor Program_MATH Applied Mathematics.

DR. MELISSA DANFORTH, CHAIR, ACADEMIC SENATE
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Bakersfield, California 93311-1022
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CHANGES TO PROGRAM FORM

Form Number

Reset Form

PROPOSAL ACTION (Select One)

EFFECTIVE CATALOG YEAR: FALL 2025

- ○ PROGRAM REVISION
- ○ PROGRAM CANCELLATION
- ○ PROGRAM PLACED IN MORATORIUM
- ○ ADD CONCENTRATION
- ○ ADD EMPHASIS
- ○ ADD OPTION
- ◉ ADD MINOR

PROGRAM OR SCHOOL & DEPARTMENT *(Required)*

School/Program: NSME/ Mathematics

Department: Mathematics

Proposed by: Maureen Rush

RATIONALE FOR DEGREE PROPOSAL *(Required)*:

Provide Rationale for Degree Proposal:

We want to offer a minor pathway to students in the sciences who may not want to take Math 3000. We list the courses that don't require Math 3000 for this minor.

DEGREE INFORMATION (MAJOR, CONCENTRATION/EMPHASIS/OPTION/MINOR)

Degree Title:
Minor in Applied Mathematics

REVISIONS TO CURRENT DEGREE DESCRIPTION AND REQUIREMENTS

Degree Description *(Attach or copy catalog copy; Use Track Changes to Add/Revise Details):*

ADDING AN OPTION, CONCENTRATION OR SPECIAL EMPHASIS (ATTACH APPROPRIATE DOCUMENTS):

Per EO 1071, before any option, concentration, or special emphasis (or similar subprogram) approved under this delegation, can be implemented, the campus shall obtain a Chancellor's Office confirmation of compliance with CSU policy and applicable law. Campus notifications shall be submitted to the Department of Academic Programs and Faculty Development (degrees@calstate.edu). The following information must be submitted:

- The exact title of the new subprogram and the complete degree designation and title of the major degree program housing the new subprogram (e.g., Bachelor of Science in Biology with a Concentration in Biochemistry);
- A list of courses and required units constituting that new subprogram;
- Total units required to complete the entire degree, including the combination of subprogram and major program;
- The complete list of courses and required units constituting the major degree program as approved by the Chancellor's Office;
- A 4-year major-and-subprogram roadmap for freshmen and a 2-year major-and-subprogram roadmap for transfer students;
- The CSU degree program code (formerly called "HEGIS") that students use to apply to the major degree program;
- The campus-proposed CSU degree program code to be used to report enrollments in the concentration (may be the same as the degree code);
- A detailed cost-recovery budget for self-support subprograms to be offered within state-support major degree programs; and
- Documentation of all campus-required curricular approvals.

ADDING A MINOR

Provide the Program Description and Minor Requirements:

Requirements for the Minor in Applied Mathematics

For majors in the sciences, a minor in Applied Mathematics is available, consisting of a minimum of 15 units, of which at least 8 units must be upper division.
Lower division courses that may count are MATH 2020, 2320, 2520, 2533, 2540, and 2610.
Upper division courses may include MATH 3200, 3300, 3500, and 4500, but may not include 3120. Only one of these courses can also be counted towards the student's major. A minimum of 8 upper division units must be completed at California State University, Bakersfield.

IMPACT OF DEGREE PROPOSAL ON OTHER PROGRAMS OR DEPARTMENTS

What Is the Impact of This Degree Proposal on Course Offerings from Other Department(S) Or Programs?

Please Include Supporting Emails with This Proposal:

none

IMPACT OF DEGREE PROPOSAL ON COURSE(S)

List All the New and Revised Courses Required for This Degree Proposal (If Applicable):

Attach/Submit All the Course Proposal Forms and Catalog Copy Together with This Form for Curricular Review and Approval

No new or revised courses.

NEXT STEPS

- **Attach Course Proposal Form(s) to This Proposal (If Applicable)**
- **Attach Catalog Copy w/ revisions (using track changes) to This Proposal**
- **Attach Appropriate Documents if Adding an Option, Concentration or Special Emphasis**
- **Attach Revised Academic Roadmap**
- **Submit to Department/Program Curriculum Committee for Review & Approval**
- **Department Submits to School/Program Curriculum Committee for Review & Approval**
- **School/Program Curriculum Committee Submits Related Forms to GECCo (If Applicable)**
- **Chancellor's Office (CO) Notification for Implementation of Option, Concentration or Special Emphasis**
- **If No Additional Approvals Are Required, School/Program Curriculum Committee Submits to Academic Operations After Final Approvals Have Been Recorded.** ***See Annual Catalog & Curriculum Deadlines Dates***

SCHOOL/PROGRAM COMMITTEE & OTHER APPROVALS:

Department Chair/Program Director: Maureen Ekrut	**Date:** 10/31/2024
School/Program Curriculum Committee Chair:	**Date:** Jan 26, 2025
Dean of School: Karlo Lopez (Jan 27, 2025 08:23 PST)	**Date:** Jan 27, 2025
Director of GE:	**Date:**
CO Notification for Implementation of Option, Concentration or Special Emphasis:	**Date:**
CO Confirmation of Compliance for Options, Concentration or Special Emphasis:	**Date:**
President's Approval for Minor:	**Date:**
WSCUC Approval:	**Date:**
Director of Academic Operations:	**Date:**

ACADEMIC OPERATIONS USE ONLY:

Effective Term:	**Catalog Year:**
CIP Code:	**HEGIS Code:**
Program Code:	**Plan Code:**
SubPlan Code:	

Developmental Mathematics

MATH 951 Modern Math and Applications Supplement (1)
Practice and review of mathematical topics needed to fully understand the content of MATH 1009. Corequisite: MATH 1009. Each section of MATH ~~0~~951 will be linked to a specific section of MATH 1009. Prerequisite: MM CAT 3 or CAT 4.

MATH 952 Statistics in the Modern World Supplement (1)
Practice and review of mathematical topics needed to fully understand the content of MATH 1209. Corequisite: MATH 1209. Each section of MATH 952 will be linked to a specific section of MATH 1209. Prerequisite: MM CAT 3 or CAT 4.

MATH 953 Number Systems and Algebraic Thinking for Preservice Elementary Teachers Supplement (1)
Practice and review of mathematical topics needed to fully understand the content of MATH 2120. Corequisite: MATH 2120. Each section of MATH 953 will be linked to a specific section of MATH 2120. Prerequisite: MM CAT 3 or CAT 4.

MATH 954 Geometry, Probability and Statistics for Preservice Elementary Teachers Supplement (1)
Practice and Review of mathematical topics needed to fully understand the content of MATH 3120. Corequisite: MATH 3120. Each section of MATH 954 will be linked to a specific section of MATH 3120. Prerequisite: MM CAT 3 or CAT 4.

Lower Division

MATH 1000 Quantitative Reasoning Experiences (1)
This course is an introduction to quantitative reasoning - presented in the form of several modules. Students will work in groups on the problems presented in the modules and present their work to the class. This course is typically offered in the Summer.

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. Students in MM CAT 3 or CAT 4 need to take this class with the supplement MATH 952. This Foundational Skills course must be completed with a grade of C- or higher. Satisfies general education requirement Area B4.

MATH 1019 Introduction to Scientific Thinking (3)
Development of critical thinking skills related to the analysis and evaluation of arguments. Topics include: analysis and criticism of deductive and inductive reasoning, justification and evidence, sentential and predicate calculus, naive set theory, and mathematical induction. Examples will focus on scientific arguments. The course involves writing complete, logically consistent arguments in English and in Mathematics to illustrate the correct use of the logical tools and methods discussed. Prerequisites: MM CAT 1 or 2. This Foundational Skills course

must be completed with a grade of C- or higher. Satisfies general education requirement GE A3 Critical Thinking.

MATH 1010 Fundamental Concepts (4)
Foundational elements of geometry, data analysis, and algebra. This course is intended for students pursuing a major in science, engineering, technology, or business. Topics include: algebra of polynomial, rational, and radical expressions; factoring; introduction to rational exponents; systems of linear equations; absolute value, quadratic, rational, and radical equations; linear and absolute value inequalities; square and higher-order roots and introduction to rational exponents; domain, range, and algebra of functions; introduction to exponential and logarithmic functions; graphs of linear and quadratic functions; graphs of basic rational, radical, exponential, and logarithmic functions; geometric formulas and applications; introduction to statistics, counting, and probability. Emphasis is on applications of concepts. For students in MM CAT 3 or CAT 4.

MATH 1020 ~~College Algebra~~ Precalculus I, 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~~ Precalculus I and II, Dual Credit Program (3)
This course is a combined version of ~~College Algebra and Trigonometry~~ Precalculus I and II. Topics include: polynomial, rational, exponential, and logarithmic functions, the fundamental theorem of algebra, and their applications, trigonometric functions, analytic trigonometry, vectors, polar form of complex numbers, polar equations, parametric equations, conic sections, and applications. Open only to students in the dual-credit portion of the CSUB Early Enrollment Program who have completed Math 1020. This Foundational Skills course must be completed with a grade of C- or higher.

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, and their applications, trigonometric functions, analytic trigonometry, vectors, polar form of complex numbers, polar equations, parametric equations, and conic sections, and applications. This Foundational Skills course must be completed with a grade of C- or higher.
Prerequisites: (1) Score of 65 or higher on the Math Placement Exam or (2) MM CAT 1 or CAT 2. ~~This Foundational Skills course must be completed with a grade of C- or higher.~~

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 requirements (1) 550 or higher on the SAT Math exam, or (2) 23 or higher on the ACT Math exam, or (3) C- or better in MATH 1010, or (4) MM CAT 1 or CAT 2. This Foundational Skills course must be completed with a

grade of C- or higher.

MATH 1051 Precalculus I Supplement (1)
This course, a supplement to MATH 1050, reinforces basic algebraic skills including exponents, roots, and factoring. Prerequisite or corequisite: MATH 1050.

MATH 1055 Precalculus I with Foundations (6)
This course includes all the material of Math 1050, plus selected foundational material such as algebra of polynomials, rational, and radical expressions, factoring, systems of linear equations, quadratic, rational, and radical equations, the midpoint and distance formulas, ratios, proportions, and similar triangles. Prerequisite: MM CAT 3 status and permission of student's advisor or the instructor.

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 in MATH 1050 or 1055; or (2) A score of 70 or higher on the Math Placement Exam. This Foundational Skills course must be completed with a grade of C- or higher.

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. Students in MM CAT 3 or CAT 4 need to take this class with the supplement MATH 952. Not open to students with credit in MATH 2200. This Foundational Skills course must be completed with a grade of C- or higher. Satisfies general education requirement Area B4.

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) SAT (Math) score of 550 or higher, or (2) ACT (Math) score of 23 or higher.

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, limits, continuity, derivatives, rules for differentiation, optimization, and stability. Trigonometry is introduced and utilized as needed 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. Prerequisite: student must satisfy one of the following requirements (1) A

grade of C- or better in MATH 1030, MATH 1040, MATH 1050, or 1055 or (2) a score of at least 70 on the MATH placement Exam, or (3) a score of 50 on the CLEP Exam. Note: this course is not a prerequisite for MATH 2320 or MATH 2520. This Foundational Skills course must be completed with a grade of C- or higher.

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 MATH 2510. This Foundational Skills course must be completed with a grade of C- or higher.

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. Students in MM CAT 3 or CAT 4 need to take this class with the supplement MATH 953.

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 mathematical software program R. Prerequisite: (1) SAT (Math) score of 550 or higher, or (2) ACT (Math) score of 23 or higher, or (3) C- or better in MATH MATH 1010, or (4) MM QR CAT 1 or 2 . This Foundational Skills course must be completed with a grade of C- or higher.

MATH 2205 Introduction to Statistical Concepts and Methods with Foundations (6)
This course includes all of the material of MATH 2200, plus foundational material such as

functions, data analysis, algebra of polynomials, rational, and radical expressions, factoring, systems of linear equations, quadratic, rational, and radical equations, graphs of linear and quadratic functions, midpoint and distance formulas, ratios, proportions. Prerequisite: QR CAT 3 status and permission of student's advisor or the instructor.

MATH 2222 Introduction to Mathematical Computing (4)
This course introduces students with little or no prior computer programming experience to basic principles of numerical computing in a mathematical context. Students will solve problems and verify conjectures by writing and calling scripts and functions, using for loops and if-else statements, and utilizing graphing technology. Topics include the Sieve of Eratosthenes, Collatz Conjecture, magic squares, Pascal's triangle, Root finding using Intermediate Value Theorem and Newton's Method, Riemann sums, optimization, systems of equations, curve fitting, chaos, and text preparation in LATEX, with other miscellaneous topics at the discretion of the instructor. Prerequisite: C- or better in MATH 2310 or MATH 2510.

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 differential ability 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 1030, MATH 1040 or MATH 1060, or (2) a score of at least 80 on the Math Placement Exam, or (3) a score of 50 on the CLEP Exam. Note: Students without recent credit in MATH 1030, MATH 1040 or MATH 1060 are advised to consult the Department of Mathematics and to take the Math Placement Exam before enrolling. This Foundational Skills course must be completed with a grade of C- or higher.

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. This Foundational Skills course must be completed with a grade of C- or higher.

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, and 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.

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 differential ability 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 1030, MATH 1040 or MATH 1060, or (2) A score of at least 80 on the Math Placement Exam, or (3) a score of 50 on the CLEP Exam. Note: Students without recent credit in MATH 1030, MATH 1040 or MATH 1060 are advised to consult the Department of Mathematics and to take the Math Placement Exam before enrolling. This Foundational Skills course must be completed with a grade of C- or higher.

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. This Foundational Skills course must be completed with a grade of C- or higher.

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, and 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.

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 2531. Note: MATH 2533 is equivalent to MATH 2531 and MATH 2532 combined.

MATH 2533 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, and 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: Compared with the previous 2 calculus courses, this course is accelerated. Students who prefer

the pace of study they are used to from MATH 2510 and MATH 2520 and/or students who earned less than a B in Calculus II should enroll in MATH 2531 and MATH 2532. These two courses cover the same material as MATH 2533. Also note: MATH 2020 is not a sufficient prerequisite for this course.

MATH 2540 Ordinary Differential Equations (4)
Topics 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. Mathematical Software will be utilized. Prerequisite: (1) C- or better in MATH 2020 or MATH 2320 or MATH 2520 and (2) C- or better in MATH 2222 or CMPS 2010.

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 bases, vector spaces, subspaces, eigenvalues, eigenvectors, diagonalization, inner products, and orthogonal projections. Appropriate technology will be utilized. Prerequisite: C- or better in MATH 2010, MATH 2310 or MATH 2510.

MATH 2770 Special Topics in Mathematics (1-4)
Topics and prerequisites to be announced. May be repeated for credit with different topics up to a maximum of 20 units.

MATH 2771 Problem Solving (1)
Course reinforces topics from precalculus, calculus or mathematics courses 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: 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: **(1)** C- or better in MATH ~~2010,~~ **2020,** MATH ~~2310~~**, 2320** or MATH ~~2510~~ **2520, and (2) prerequisite or corequisite MATH 2222**.

MATH 3100 Early Field Experiences (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.

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. Students in MM CAT 3 or CAT 4 need MATH 954 as a corequisite.

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: Student must satisfy at least one of the following requirements (1) C- or better in MATH 3120, or (2) post-baccalaureate standing and permission of the instructor.

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. Prerequisite: Student must satisfy one of the following requirements (1) C- or better in MATH 2200 and MATH 3120, or (2) post-baccalaureate standing and permission of the Instructor.

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 MATH 1060, and in MATH 3120, or (2) post-baccalaureate standing and permission of the Instructor.

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. Prerequisite: C- or better in MATH 2320 or MATH 2520. Recommended MATH 2330 or MATH 2531 or MATH 2533.

MATH 3209 Statistical Measures of Inequalities (3)
This course uses statistical measures as a basis for exploring dimensions of social and environmental inequalities, and why some groups are more effective than others at addressing social and environmental problems. The course will also consider the role the field of statistics has played in the development of science and industry that has contributed to the further understanding of issues in environmental inequalities. Prerequisites: At least 45 units and completion of LD Area D. Satisfies general education upper division Area UDD and Theme S: Sustainability and Justice.

MATH 3210 Applied Statistical Computing and Multivariate Methods (4)
Introduction to common applied multivariate statistical~~-~~, topics in data management, and interactive data visualization~~methods that provide inferences about several variables from a population~~. Use of R programming language ~~statistical software~~ to motivate understanding of a wide variety of issues related to ~~the~~ data management and the analysis of complex datasets and programming with data. ~~of data in today's data centric world~~. Essential programming concepts include~~: typical~~ data processing tasks, data manipulation, ~~looping structures,~~ conditional execution, and other data management fundamentals~~techniques~~. Statistical analyses covers ~~include:~~ high-dimensional data visualization, ~~matrix algebra notation and literacy,~~ principal components, and factor analysis. For visualization, interactive data-driven dashboards with R Shiny will be created, integrating visualizations and user interfaces to enable real-time exploration and storytelling~~, and discriminant and classification analysis. Additional topics may include clustering, LaTeX, or special topics selected by instructor~~. ~~Use of R and/or SAS throughout the course.~~ No previous programming experience required. Prerequisite: C- or better in MATH 2200 or SOC 2208 or PSCY 2018 or KINE 2018 or BIOL 3120 or Math 4200.

MATH 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) and/or numerical software may be used to program numerical algorithms and identify their limitations. Each week lecture meets for 200 minutes. Prerequisites: (1) C- or better in MATH 2020, MATH 2320, or MATH 2520, and (2) C- or better in MATH 2610, **and** (3) ~~or~~ CMPS 2010 or **MATH 2222**. Carries credit in CMPS 3300.

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: (1) C- or better in MATH 3000 **or CMPS 2120**, **and (2) pre or co-requisite MATH 2610**.

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.

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 2330, MATH 2532 or MATH 2533.

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: (1) C- or better in MATH 2320 or MATH 2520, and (2) C- or better in MATH 3000.

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 (Z_n, U_n, Cyclic and Dihedral Groups, Frieze Groups, isometries of the plane, homomorphisms, subgroups, and quotient groups), rings (Z, Z_m, Q[x], and matrices), domains (integral and Euclidean), fields (Q, R, C, and Z_p), ordered fields, subfields of C, and solutions of polynomials over R and C. Prerequisites: C- or better in both MATH 2610 and MATH 3000.

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 MATH 3000.

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: (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).

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.

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.

MATH 4210 Regression Modeling and Analysis (4)
Advanced course in applied regression analysis. Students develop a sense of the applicability of regression as a tool for analysis of data. Topics include: linear regression, randomization tests for linear regression, correlation analysis, model diagnostics and remedial measures, matrix algebra notation and literacy for developing concepts of linear regression, variable and model selection techniques. Additional topics may include Poisson regression, logistic regression, path analysis, forecasting, and special topics selected by instructor. Statistics software R or SAS is used throughout the course. Prerequisite: C- or better in MATH 2200 or SOC 2208 or PSCY 2018 or KINE 2018 or BIOL 3120 or Math 4200. Recommended: MATH 3210.

MATH 4220 Applied Statistical Methods for Data Science ~~Design and Analysis of Experiments~~ (4)

A comprehensive introduction to advanced statistical methods with a focus on data-driven problem-solving. This course bridges the gap between statistical theory and real-world data science application, preparing students to analyze complex datasets and implement predictive models effectively. Students will gain the skills needed to apply statistical techniques to real-world challenges in data science. Practical computing with R is emphasized. No previous programming experience required. Prerequisite: C- or better in MATH 2200 or SOC 2208 or PSCY 2018 or KINE 2018 or BIOL 3120 or Math 4200. Recommended: MATH 3210.

~~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 MATH 4200. Recommended: MATH 3210.~~

MATH 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. Prerequisite: (1) C- or better in MATH 2020, MATH 2320, or MATH 2520, and (2) C- or better in MATH 3000 or CMPS 2120. Carries credit as CMPS 4300.

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. Prerequisite: C- or better in MATH 2530, MATH 2531 or MATH 2533 and MATH 2540.

MATH 4520 Analysis II (4)
A continuation of Analysis I. Topics may include: the topology of the real line, Lebesgue measure, non-measurable 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.

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.

MATH 4610 Linear Algebra II (4)
Continuation of Linear Algebra I. Topics selected from: 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, MATH 2320, or MATH 2520, and (2) C- or better in MATH 2610 and MATH 3000.

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.

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. May be repeated for credit with different topics up to a maximum of 4 units.

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

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.

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. May be repeated up to a maximum of 20 units.

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) Senior Status; and (2) Completion of JYDR; and (3) C- or better in at least four upper division courses from the Applied, Pure, or Statistics Concentrations; and (4) Satisfaction of the CSUB Graduation Writing Assessment Requirement (GWAR). Satisfies general education requirement Capstone. May be repeated for credit.

MATH 4918 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) Senior Status; and (2) Completion of JYDR; and (3) C- or better in at least four upper division courses from the Teaching Concentration; and (4) Satisfaction of the CSUB Graduation Writing Assessment Requirement (GWAR). Satisfies general education requirement Capstone.

MATH 5210 Applied Statistical Computing and Multivariate Methods (4)

This course introduces graduate students to common applied multivariate statistical , topics in data management, and interactive data visualization. Use of the R programming language to motivate understanding ~~methods and the use of statistical software to motivate understanding~~ of a wide variety of issues related to data management and the analysis of complex datasets and programming with data. Essential programming concepts include data processing tasks, data manipulation, conditional execution, and other data management fundamentals. Statistical analyses covers high-dimensional data visualization, principal components analysis, and factor analysis. For visualization, interactive data-driven dashboards with R Shiny will be created, integrating visualizations and user interfaces to enable real-time exploration and storytelling. ~~the management of data~~. Emphasis may be placed on applications to areas relevant to the graduate students' field of study. Prerequisites: Graduate standing and MATH 2200, **BIOL 3120** or equivalent.

Requirements for the Minor in Applied Statistics
Although no minor is required for the BS degree in Mathematics, a minor in Statistics is available, consisting of a minimum of **15** units chosen from MATH 2200 (or equivalent), 3200, 3210, 4200, 4210 and 4220. Only one of these courses can also be counted towards the student's major. A minimum of eight upper division units must be completed at California State University, Bakersfield.

Requirements for Minor in Mathematics
Although no minor is required for the BS degree in Mathematics, a minor in Mathematics is available. The requirement is a minimum of 15 ~~16~~ units, at least 8 of which must be upper division. Lower division courses that can count are MATH 2020, 2320, 2520, 2533, ~~and~~ 2540, and 2610. An upper division course that does not count is MATH 3120. Only one of these courses can also be counted towards the student's major. A minimum of eight upper division units must be completed at California State University, Bakersfield.

Requirements for the Minor in Applied Mathematics
For majors in the sciences, a minor in Applied Mathematics is available, consisting of a minimum of 15 units, of which at least 8 units must be upper division.
Lower division courses that may count are MATH 2020, 2320, 2520, 2533, 2540, and 2610.
Upper division courses may include MATH 3200, 3300, 3500, and 4500. Only one of these courses can also be counted towards the student's major. A minimum of 8 upper division units must be completed at California State University, Bakersfield.