# Department of Mathematics

**Jack Brown Hall, Room 370**
**(909) 537-5361 Department of Mathematics website (http://www.csusb.edu/mathematics/)**

The Department of Mathematics offers a Bachelor of Arts degree and a Bachelor of Science degree. The Bachelor of Arts degree is appropriate for students pursuing a mathematics-related career. The Bachelor of Science degree is appropriate for students pursuing a career in a mathematics-intensive field. The Bachelor of Science degree has three concentrations: general mathematics, applied mathematics, and teaching mathematics.

In addition to our undergraduate degree programs, the department offers a minor in mathematics, a certificate in Introductory Mathematics, and a certificate in Introductory Actuarial Science.

The department also offers a Master of Arts degree designed for those wishing to pursue a career in teaching mathematics at the community college level or those wishing to pursue a higher degree in mathematics or a related field.

In many ways mathematics functions as a universal language in today's global culture. Upper-division students are encouraged to participate in the California State University's International Programs (https://catalog.csusb.edu/csu-system/#internationalprogramstext).

The department's Center for Enhancement of Mathematics Education (https://www.csusb.edu/ceme/) organizes many activities aimed at improving mathematics teaching and learning in K-12 schools. We encourage undergraduates interested in mathematics teaching careers to acquaint themselves with these programs.

**Preparing for Teaching Credential Programs**

One of the requirements to enter the Single Subject Credential Program is verification of subject matter competency. For mathematics, to be best prepared for the credential program and future teaching, students should complete the requirements of the B.S. in Mathematics, Teaching Mathematics Concentration with a C or better in all required math courses. If students choose to instead complete a different Mathematics degree program, then it is strongly recommended that students consult with a faculty advisor to select appropriate math elective courses. If a student completes a degree in another field but still wants to earn a Single Subject Credential in Mathematics, then the student must pass the Mathematics CSET Subtests I, II and III or the equivalent coursework as approved by the Mathematics Department. Other prerequisites of the teacher education program must be met, including a minimum GPA requirement.

Important: verifying subject matter competency is only one of several requirements for admission to the Single Subject Credential Program. Students interested in that program must refer to the Program Admissions Advising page on the College of Education website or contact College of Education Student Services in CE-102 for a complete and up-to-date list of requirements. We recommend doing so as soon as possible, since some items may take time to complete.

**Departmental Honors**

The department faculty will determine whether a student is to be awarded departmental honors upon graduation. The criteria will be:

1. A grade point average of at least 3.5 in all mathematics courses taken at this university and counted toward fulfilling requirements of the mathematics major.
2. MATH 5953, completed with a grade of "A-" or better, and culminating in a presentation to the department.

## Emerita

Susan L. Addington, Professor of Mathematics
B.S. 1976, Marlboro College
M.A. 1978, Ph.D. 1981, State University of New York at Stony Brook

## Current Faculty

Joyce C. Ahlgren, Lecturer in Mathematics
B.A. 1972, University of California, Santa Barbara
M.A. 2003, California State University, San Bernardino

Lida Ahmadi, Assistant Professor of Mathematics
B.S. 2011, University of Tehran
Ph.D. 2019, Purdue University

Jeremy Aikin, Professor of Mathematics
B.S. 2003, University of California, Riverside
M.S. 2005, Ph.D. 2009, Louisiana State University

Mark Ballard, Lecturer in Mathematics
M.A. 1977, University of California, Irvine

Corey M. Dunn, Professor of Mathematics
B.S. 2000, Pacific Lutheran University
M.S. 2002, Ph.D. 2006, University of Oregon

Nadia Dyakevich, Professor of Mathematics
M.Sc. 1997, Moscow State Institute of Electronics and Mathematics
M.S. 1998, University of Southwestern Louisiana
Ph.D. 2002, University of Louisiana at Lafayette

Hajrudin Fejzic, Professor of Mathematics
B.S. 1987, University of Sarajevo, Sarajevo, Bosnia and Herzogovina
Ph.D. 1992, Michigan State University

D. Raleigh Guthrey, Lecturer in Mathematics
B.A. 1997, M.A. 1998, California State Polytechnic University, Pomona

Ilseop Han, Professor of Mathematics
B.A. 1986, M.S. 1988, Korea University
Ph.D. 1999, University of California, San Diego

Zahid Hasan, Professor of Mathematics
B.Sc. 1973, M.Sc. 1976, University of Punjab, Pakistan
Ph.D. 1982, University of Birmingham, England

Madeleine Jetter, Professor of Mathematics, Chair
B.A. 1999, Columbia University
M.A. 2001, Ph.D. 2007, University of California, Los Angeles

Cory Johnson, Professor of Mathematics
B.S. 2009, University of Redlands
Ph.D. 2014, Colorado State University

Yuichiro Kakihara, Professor of Mathematics
B.S. 1974, M.S. 1976, Dr. Sci. 1985, Tokyo Institute of Technology, Japan

Su Liang, Associate Professor of Mathematics
B.A. 2003, M.S. 2007, Ph.D. 2010, University of Connecticut

Giovanna Llosent, Professor of Mathematics
B.A. 1999, University of Costa Rica
M.S. 2006, Ph.D. 2007, University of Iowa

Min-Lin Lo, Professor of Mathematics
B.S. 1997, National Tsing-Hua University, Taiwan
M.A. 2000, Ph.D. 2004, State University of New York at Buffalo

Shawnee L. McMurran, Professor of Mathematics
B.S. 1985, M.S. 1987, Ph.D. 1991, University of California, Riverside

Jeff Meyer, Associate Professor of Mathematics
B.S. 2007, University of Chicago
Ph.D. 2013, University of Michigan

Lynn Scow, Associate Professor of Mathematics
B.A. 2004, Ph.D 2010, University of California, Berkeley

Rolland Trapp, Professor of Mathematics
B.A. 1984, Knox College
M.A. 1985, Ph.D. 1990, Columbia University

Laura J. Wallace, Professor of Mathematics
B.S. 1991, California State Polytechnic University, Pomona
M.S. 1992, Ph.D. 1998, University of California, Riverside

Wenxiang Wang, Professor of Mathematics
B.A. 1982, Tsinghua University, Beijing, China
M.A. 1984, Ph.D. 1988, Princeton University

Peter D. Williams, Professor of Mathematics, Interim Associate Dean
B.S. 1979, Ph.D. 1983, University of St. Andrews, Scotland

## Emeriti

Joseph D. Chavez, Professor of Mathematics
B.S. 1982, University of San Francisco
M.S. 1985, Ph.D. 1987, University of California, Riverside

Davida D. Fischman, Professor of Mathematics

Christopher F. Freiling

Gary R. Griffing

James S. Okon

Chetan Prakash

Dan C. Rinne

John Sarli

Charles S. Stanton, Professor of Mathematics
A.B. 1977, University of California, Berkeley
M.A. 1980, Ph.D. 1982, University of Wisconsin, Madison

Robert G. Stein

Belisario Ventura, Professor of Mathematics
Licen. 1976, University of del Valle, Guatemala
M.A. 1978, Ph.D. 1984, University of California, Berkeley

J. Paul Vicknair, Professor of Mathematics
B.S. 1974, M.S. 1978, Ph.D. 1982, Louisiana State University

# Undergraduate Degrees

## Bachelor of Arts

Mathematics (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/mathematics-ba/)

## Bachelor of Science

Mathematics (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/mathematics-bs/) with concentrations in:

- General Mathematics
- Applied Mathematics
- Teaching Mathematics

# Graduate Degrees

## Master of Arts

Mathematics (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/mathematics-ma/)

Teaching - Mathematics (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/teaching-mathematics-ma/)

# Minor

- Mathematics (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/mathematics-minor/)
- Statistics (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/statistics-minor/)

# Certificates

- Introductory Actuarial Science (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/introductory-actuarial-science-certificate/)
- Introductory Mathematics (https://catalog.csusb.edu/colleges-schools-departments/natural-sciences/mathematics/introductory-mathematics-certificate/)

# Courses

## MATH 1001L. Quantitative Reasoning Lab. Unit: 1

Instruction and practice in quantitative reasoning. Topics include advanced place value reasoning, efficient estimation and mental computation, units of measure, advanced proportional reasoning, communicating quantitative information verbally and visually, mathematical technology. Activities may include computer-aided instruction. Placement determined by campus placement standards and consultation with an advisor. Recommended for students in General Education QR courses, statistics courses, or other quantitative methods courses in other disciplines. Graded Credit/No Credit.

## MATH 1101. Mathematics and Society. Units: 3

Fundamentals of mathematics with applications to issues of personal and civic life. Personal finance, and topics such as voting and social choice, data science, chance. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. Placement determined by campus placement standards and advising. Satisfies GE B4/2.

## MATH 1102. Stretch Mathematics and Society A. Units: 3

Fundamentals of mathematics with applications to issues of personal and civic life. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. First term of a two-term version of Math 1101. Successful completion of the two-term sequence Math 1102-1103 satisfies the GE B4/2. Placement determined by campus placement standards and consultation with an advisor. May not be taken for credit by students who have completed Math 1101, 115, 116A or 117B. Graded A through C-/No Credit.

## MATH 1103. Stretch Mathematics and Society B. Units: 3

Quarter Prerequisite: MATH 116A or MATH 117B

Fundamentals of mathematics with applications to issues of personal and civic life. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. Second term of a two-term version of Math 1101. Successful completion of the two-term sequence Math 1102-1103 satisfies GE B4/2. Placement determined by campus placement standards and consultation with an advisor. May not be taken for credit by students who have completed Math 1101, 115, 116B or 117C. Graded A through C-/No Credit.

## MATH 1104. Mathematics and Society with Support Lab. Units: 4

Fundamentals of mathematics with applications to issues of personal and civic life. Personal finance, and topics such as voting and social choice, data science, and chance. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. Three hours lecture and three hours lab. Placement determined by campus placement standards and advising. May not be taken for credit by students who have completed Math 1101, Math 1103 or Math 115. Graded A through C-/no credit. Satisfies GE B4/2.

## MATH 1201. Introduction to Statistical Thinking. Units: 3

Introductory statistics with applications to a variety of disciplines. Critical thinking about real data, methods of analysis, and implications. Topics: collection, organization and representation of data, including sampling and experimental design; inferences, predictions, and arguments based on data, including correlation, confidence intervals, and hypothesis testing; and basic notions of chance and probability. Use of technology for displaying and analyzing data. Placement determined by campus placement standards and advising. Graded A through C-/No Credit. Satisfies GE B4/2.

## MATH 1202. Stretch Introduction to Statistical Thinking A. Units: 3

Introductory statistics with applications to a variety of disciplines. Critical thinking about real data, methods of analysis, and implications. Use of technology for displaying and analyzing data. First term of a two-term version of Math 1201. Successful completion of the two-term sequence Math 1202-1203 satisfies GE B4/2. Placement determined by campus placement standards and advising. May not be taken for credit by students who have completed Math 1201 or Math 165. Graded A through C-/No Credit.

## MATH 1203. Stretch Introduction to Statistical Thinking B. Units: 3

Introductory statistics with applications to a variety of disciplines. Critical thinking about real data, methods of analysis, and implications. Use of technology for displaying and analyzing data. Second term of a two-term version of Math 1201. Successful completion of the two-term sequence Math 1202-1203 satisfies GE B4/2. Placement determined by campus placement standards and advising. May not be taken for credit by students who have completed Math 1201 or Math 165. Graded A through C-/No Credit.

## MATH 1204. Introduction to Statistical Thinking with Support Lab. Units: 4

Introductory statistics with applications to a variety of disciplines. Critical thinking about real data, methods of analysis, and implications. Topics: collection, organization and representation of data, including sampling and experimental design; inferences, predictions, and arguments based on data, including correlation, confidence intervals, and hypothesis testing; and basic notions of chance and probability. Use of technology for displaying and analyzing data. Three hours lecture and three hours lab. Placement determined by campus placement standards and advising. May not be taken for credit by students who have completed MATH 1201, 1203 or 165. Graded A through C-/No Credit. Satisfies GE B4/2.

## MATH 1301. Modeling with Functions. Units: 3

Algebraic and geometric concepts of functions of one variable, including linear, exponential, logarithmic, and power functions. Applications to business, government, science, and other fields. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. Placement determined by campus placement standards and advising. Previously offered as MATH 110, students may not receive credit for both. Graded A through C-/No Credit. Satisfies GE B4/2.

## MATH 1302. Stretch Modeling with Functions A. Units: 3

Algebraic and geometric concepts of functions of one variable, including linear, exponential, logarithmic, and power functions. Applications to business, government, science, and other fields. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. First term of a two-term version of Math 1301. Successful completion of the two-term sequence Math 1302-1303 satisfies GE B4/2. Placement determined by campus placement standards and advising. May not be taken for credit by students who have completed Math 1301, Math 110, Math 111A or Math 112B. Graded A through C-/No Credit.

## MATH 1303. Stretch Modeling with Functions B. Units: 3

Semester Prerequisite: MATH 1302
Algebraic and geometric concepts of functions of one variable, including linear, exponential, logarithmic, and power functions. Applications to business, government, science, and other fields. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. Second term of a two-term version of Math 1301. Successful completion of the two-term sequence Math 1302-1303 satisfies GE B4/2. Placement determined by campus placement standards and advising. May not be taken for credit by students who have completed Math 1301, Math 110, Math 111B or Math 112C. Graded A through C-/No Credit.

## MATH 1304. Modeling with Functions with Support Lab. Units: 4

Algebraic and geometric concepts of functions of one variable, including linear, exponential, logarithmic, and power functions. Applications to business, government, science, and other fields. Use of spreadsheets and other technologies for visualization, experimentation, and problem solving. Three hours lecture and three hours lab. Placement determined by campus placement standards and advising. May not be taken for credit by students who have completed MATH 1301, 1303 or 110. Graded A through C-/No Credit. Satisfies GE B4/2.

## MATH 1401. Accelerated Preparation for Calculus. Units: 4

An accelerated course covering the content of Math 1402 and 1403 in one term. Algebraic and geometric concepts and skills needed for calculus. The algebra of functions, including linear, exponential, logarithmic, trigonometric, polynomial, and rational functions. Use of mathematical technologies for visualization, experimentation, and problem solving. Directed self-placement in this course is based on campus placement standards, mathematics department assessments, and advising. Formerly offered as the MATH 110, MATH 120 sequence. May not be taken for credit by students who have completed MATH 120 or MATH 1403. Graded A through C-/no credit. Satisfies GE Category B4.

## MATH 1402. Preparation for Calculus A. Units: 3

Algebraic and geometric concepts and skills needed for calculus. The algebra of expressions, equations and functions, including linear, exponential, logarithmic, and polynomial functions. Use of mathematical technologies for visualization, experimentation, and problem solving. Directed self-placement in this course is based on campus placement standards, mathematics department assessments and consultation with an advisor. May not be taken for credit by students who have completed Math 1401 or Math 120. Graded A through C-/no credit. Satisfies GE B4/2.

## MATH 1402L. Preparation for Calculus A Lab. Unit: 1

Semester Corequisite: Math 1402
Additional instruction in algebraic and geometric concepts and skills needed for calculus, including the algebra of expressions, equations and functions. Use of mathematical technologies for visualization, experimentation, and problem solving. Directed self-placement in this course is based on campus placement standards, mathematics department assessments and consultation with an advisor. May not be taken for credit by students who have completed Math 1401, 1402, 1403 or Math 120. Graded credit/no credit.

## MATH 1403. Preparation for Calculus B. Units: 3

Semester Prerequisite: MATH 1402
Algebraic and geometric concepts and skills needed for calculus. The algebra of functions, including linear, trigonometric functions, rational functions and their limits. Use of mathematical technologies for visualization, experimentation, and problem solving. Directed self-placement in this course is based on campus placement standards, mathematics department assessments and consultation with an advisor. May not be taken for credit by students who have completed Math 1401 or Math 120. Graded A through C-/no credit. Satisfies GE B4/2.

## MATH 1403L. Preparation for Calculus B Lab. Unit: 1

Semester Corequisite: Math 1403
Additional instruction in algebraic and geometric concepts and skills needed for calculus, including including trigonometric functions, rational functions and their limits. Use of mathematical technologies for visualization, experimentation, and problem solving. Directed self-placement in this course is based on campus placement standards, mathematics department assessments and consultation with an advisor. May not be taken for credit by students who have completed Math 1401, 1403 or Math 120. Graded credit/no credit.

## MATH 1501. Critical Thinking Through Applications of Mathematical Logic. Units: 3

Analysis of formal and informal arguments from a wide range of examples drawn from everyday and mathematical contexts. Comparison of logic in natural and mathematical language. Inductive and deductive reasoning. Students will present and critique arguments in small peer groups. Formerly offered as MATH 180, students may not receive credit for both courses. Satisfies GE A3/1B.

## MATH 1601. Modeling with Calculus. Units: 3

Semester Prerequisite: MATH 1301 or MATH 1303 or MATH 1401 or MATH 1402 or equivalent or satisfactory placement status
Survey of differential and integral calculus with emphasis on conceptual understanding and modeling the world around us. Use of mathematical technologies for visualization, experimentation, and problem solving. Not a substitute for any course in the calculus sequence MATH 2210, MATH 2220, MATH 2310, MATH 2320. Satisfies GE B4/2.

## MATH 2210. Calculus I. Units: 4

Semester Prerequisite: Math 1401 or Math 1403 or satisfactory score on department placement exam
Differentiation of functions in one variable with an emphasis on conceptual understanding, problem solving, multidisciplinary applications, and use of technology for numerical methods and graphical representation. Topics will include limits, continuity, derivatives, modeling, optimization, and related rates. Additional topics include definite and indefinite integrals and the Fundamental Theorem of Calculus. Satisfies GE B4/2.

## MATH 2210L. Calculus I Lab. Unit: 1

Semester Corequisite: Math 2210
Additional instruction in algebraic and geometric concepts and skills needed for Calculus I. Use of mathematical technologies for visualization, experimentation, and problem solving. Recommended for students registered in Math 2210. Directed self-placement in this course is based on campus placement standards, mathematics department assessments and consultation with an advisor. May not be taken for credit by students who have completed Math 211 or Math 2210. Graded Credit/No Credit.

## MATH 2220. Calculus II. Units: 4

Semester Prerequisite: MATH 2210 or MATH 2120Q2S with a grade of C- (1.7) or better

Integration of functions in one variable with an emphasis on conceptual understanding, problem solving, multidisciplinary applications, and use of technology for numerical methods and graphical representation. Topics will include definite and indefinite integrals, applications of integration, modeling, techniques of integration, numerical integration, sequences and series, power series, parametric equations, and polar coordinates. Formerly offered as part of the MATH 211, 212, 213 sequence. Students may not earn credit for both MATH 213 and MATH 2220.

## MATH 2220L. Calculus II Lab. Unit: 1

Semester Corequisite: Math 2220

Additional instruction in algebraic and geometric concepts and skills needed for Calculus II. Use of mathematical technologies for visualization, experimentation, and problem solving. Recommended for students registered in Math 2220. Directed self-placement in this course is based on campus placement standards, mathematics department assessments and consultation with an advisor. May not be taken for credit by students who have completed Math 212 or Math 2220. Graded Credit/No Credit.

## MATH 2229L. Two-Dimensional Geometry Lab. Unit: 1

Two-dimensional geometry using technology and hands-on constructions. Topics include Euclidean geometry constructions, transformations, graphs of functions, parametrized curves. Recommended for students in or preparing for calculus, Math 3329, and future secondary teachers. Graded Credit/No Credit.

## MATH 2239L. Three-Dimensional Geometry Lab. Unit: 1

Prerequisites: Math 2229L. Graded Credit/No Credit

Three-dimensional geometry using technology and hands-on constructions. Topics include lines and planes, polyhedra, curves and surfaces, graphs of functions of several variables, vector computations. Recommended for students in Math 2310, Math 2320, and future secondary teachers. Recommended.

## MATH 2265. Statistics with Applications. Units: 3

Semester Prerequisite: MATH 2210 as a pre- or co-requisite. Quarter Prerequisite: MATH 211 as a pre- or co-requisite

Acquisition, organization, evaluation, and visual representation of data. Multivariate data, correlation, and regression. Estimation of parameters. Inference, including classical hypothesis testing. Computer-based simulations and the use of resampling methods. Emphasis on applications to real data. Formerly MATH 262; students may not earn credit for both.

## MATH 2270. Differential Equations with Dynamical Systems I. Units: 3

Semester Prerequisite: MATH 2310. Quarter Prerequisite: MATH 251

Differential equations theory and applications. First-order linear and nonlinear differential equations with analytic and numerical techniques. Planar and higher order systems of linear differential equations with constant coefficients. Slope fields and phase portraits. Formerly Math 270; students may not earn credit for both.

## MATH 2310. Applied Linear Algebra. Units: 4

Semester Prerequisite: MATH 2210 with a grade of C- or better; and MATH 2220 as a pre- or co-requisite. Quarter Prerequisite: MATH 212 with a grade of C- or better

Introduction to the algebra and geometry of vectors and matrices over the real numbers with an emphasis on conceptual understanding and applications. Topics will include solving systems of linear equations, linear transformations, eigenvalues and eigenvectors, vector products, orthogonal projections, and vector parametrizations of curves in two and three dimensions. Applications of these topics may include computer graphics, electrical networks, difference equations, dynamical systems, and economics. Students should expect to make appropriate use of technology for visualization and computation. Formerly part of MATH 251 and MATH 331; students may not earn credit for both MATH 2310 and MATH 331.

## MATH 2320. Multivariable Calculus. Units: 4

Semester Prerequisite: MATH 2220 and MATH 2310 with a grade of C- or better. Quarter Prerequisite: MATH 251 and MATH 213 with a grade of C- or better

An extension of the notions of differentiation and integration to functions of several variables, vector analysis, and applications. Applications of differentiation will include linear approximation, directional derivatives, and optimization. Applications of integration will include area, volume, and other physical applications such as centers of mass, work, and flux. The course culminates with important theorems in vector analysis, in particular, those of Gauss, Green, and Stokes. Formerly part of the MATH 251 and MATH 252 sequence; students may not earn credit for MATH 2320 and MATH 252.

## MATH 2372. Discrete Mathematics. Units: 3

Semester Prerequisite: Completion of the Quantitative Reasoning General Education requirement. Quarter Prerequisite: Completion of the general education requirement in mathematics

Introduction to the study and use of discrete mathematical structures including number systems and bases, propositional logic, sets, Boolean algebra, functions and relations, and induction. Additional topics may include graph theory and asymptotic notation as time permits. May not be counted toward fulfilling requirements in the mathematics major. Formerly Math 272. Formerly Math 2720. May not be taken for credit by students who have completed Math 272 or Math 2720.

## MATH 2900. Problem Solving and Mathematical Reasoning for Teachers I. Units: 4

Semester Prerequisite: MATH 1401 or MATH 1403 or MATH 2210. Quarter Prerequisite: MATH 120 or MATH 211

Development of problem solving skills for future secondary teachers that foster mathematical habits of mind and practices. Incorporation of technological tools for teaching and learning secondary school mathematics. Emphasis on flexible thinking with a variety of strategies and representations. Topics include numerical reasoning, algebraic thinking, proportional reasoning and structure of number systems with connections to geometry. Formerly MATH 199 and MATH 299; students may not earn credit for both MATH 299 and MATH 2900. Graded ABC/NC.

## MATH 3010. Mathematical Concepts and Problem Solving for Educators I. Units: 4

Semester Prerequisite: Completion of the general education requirements in quantitative reasoning, written communication, oral communication and critical thinking

Pedagogical content knowledge, problem solving skills, and communication skills in mathematics. Mathematical reasoning behind the structure and arithmetic of the real number system. Connections between numbers, measurement, and geometry. Mathematical content knowledge and skills related to the K-8 curriculum, at the conceptual depth required for high-quality teaching. Includes activities intended to support students in flexibly applying these skills. A demonstration of mastery of fundamental skills as determined by the Department of Mathematics is required for credit. Three hours seminar and one hour discussion. May not be counted toward fulfilling requirements in the mathematics major. Formerly Math 3011 and Math 3011L. Formerly part of the Math 301ABC and Math 308 sequence. May not be taken for credit by students who have completed MATH 301A or Math 3011. Graded ABC/No Credit.

## MATH 3012. Mathematical Concepts and Problem Solving for Educators II. Units: 3

Semester Prerequisite: Completion of MATH 3010 or MATH 3011 with a course grade of at least C

Pedagogical content knowledge, problem solving skills, and communication skills in mathematics related to the K through 8 curriculum, at the conceptual depth required for high quality teaching. Development of algebraic thinking and multiplicative structures. Investigation of linear and proportional relationships through multiple representations. A demonstration of mastery of fundamental skills as determined by the Department of Mathematics is required for credit. Concurrent enrollment in MATH 3012L is recommended. May not be counted toward fulfilling requirements in the mathematics major. Formerly part of the Math 301ABC and Math 308 sequence. May not be taken for credit by students who have completed MATH 301B. Graded ABC/No Credit.

## MATH 3012L. Proportional Reasoning Lab for Educators. Unit: 1

Semester Corequisite: Math 3012

Mathematical content knowledge and skills related to the K-8 curriculum, at the conceptual depth required for high-quality teaching. Skills and concepts to include measurement, multiplicative structures, proportional reasoning and algebraic thinking. Lab activities intended to support students in flexibly using fundamental skills required for passage of Math 3012. Recommended for students registered in Math 3012. Directed self-placement in this course is based on mathematics department assessments and consultation with an advisor. Graded Credit/No Credit. May be repeated for credit two times for a total of 2 units.

## MATH 3013. Mathematical Concepts and Problem Solving for Educators III. Units: 3

Semester Prerequisite: Completion of MATH 3012 with a course grade of at least C. Quarter Prerequisite: Completion of MATH 301B with a grade of C or better

Pedagogical content knowledge, problem solving skills, and communication skills in mathematics related to the K through 8 curriculum, at the conceptual depth required for high quality teaching. Conceptual foundations of measurement and data analysis. Geometric reasoning about figures in 2 and 3 dimensions, including concepts of congruence, similarity, and geometric transformations. A demonstration of mastery of fundamental skills as determined by the Department of Mathematics is required for credit. Concurrent enrollment in MATH 3013L is recommended. May not be counted toward fulfilling requirements in the mathematics major. Formerly part of the Math 301ABC and Math 308 sequence. May not be taken for credit by students who have completed MATH 301C. Graded ABC/No Credit.

## MATH 3013L. Algebra and Geometry Lab for Educators. Unit: 1

Semester Corequisite: Math 3013

Mathematical content knowledge and skills related to the K-8 curriculum, at the conceptual depth required for high-quality teaching. Skills and concepts to include polynomial and other nonlinear functions, and geometric reasoning about figures in 2 and 3 dimensions. Lab activities intended to support students in flexibly using fundamental skills required for passage of Math 3013. Recommended for students registered in Math 3013. Directed self-placement in this course is based on mathematics department assessments and consultation with an advisor. Graded Credit/No Credit. May be repeated for credit 2 times for a total of 2 units.

## MATH 3100. Mathematical Thinking: Communication and Proof. Units: 4

Semester Prerequisite: MATH 2220 with a grade of C- or better

Disciplinary ways of thinking in mathematics with emphasis on the construction of valid mathematical arguments, critiques of arguments, and structure of professional mathematical writing including typesetting. Content will include topics from logic, set theory, divisibility, modular arithmetic, properties of real numbers, properties of relations/functions, and methods of proof. Three hours of lecture and one hour online. Graded ABC/NC. Satisfies WI designation.

## MATH 3140. Introduction to Systems Modeling. Units: 3

Semester Prerequisite: Completion of GE 2

Construction of mathematical models and simulations of complex systems with many inputs and outputs using systems modeling software. Applications to include environmental, economic/business, social, scientific, and medical systems. Satisfies GE B5/UD-5, Environmental Sustainability, Diversity and Social Justice pathways.

## MATH 3178. Methods and Practices for Teaching Mathematics. Unit: 1

Semester Prerequisite: A cumulative GPA of at least 2.9 in MATH courses numbered 2000 or higher. Quarter Prerequisite: A cumulative GPA of at least 2.9 in MATH courses numbered 200 or higher
Seminar on evidence-based teaching practices in mathematics. Topics include how people learn, active learning pedagogies, use of technology in teaching and learning, cognitive considerations, and ways of thinking in mathematics. Course expectations include study of research on mathematics learning and teaching and participation in learning community activities such as peer observations and lesson study. Consent of instructor required. Graded Credit/No-Credit. May be repeated for credit.

## MATH 3320. Mathematical Interest Theory. Units: 3

Semester Prerequisite: MATH 2220 with a grade of C- or better. Quarter Prerequisite: MATH 213 with a grade of C- or better and MATH 241
Development of the mathematical theory of interest, including special cases of simple and compound interest, nominal and effective rates of interest, force of interest, and discount rate. Application of the theory to actuarial science, including the valuation of various streams of cash flow, annuities, yield rates, loans, and bonds. Formerly MATH 320; students may not earn credit for both.

## MATH 3329. Euclidean Geometry with Transformations. Units: 3

Semester Prerequisite: MATH 3100 and high school geometry or equivalent; MATH 2310 as a pre- or co-requisite. Quarter Prerequisite: MATH 251 and high school geometry or equivalent
Euclidean geometry with emphasis on deductive proof and written communication. Definition of congruence and similarity by transformations. History of important theorems with analysis of dependence on Euclid's parallel postulate. Classification and construction of planar rigid motions and similarities. Formerly Math 329; students may not earn credit for both.

## MATH 3345. Number Theory. Units: 3

Semester Prerequisite: Math 3100. Quarter Prerequisite: MATH 355
Classical number theory. Topics include the Euclidean Algorithm, Diophantine equations, primes, linear congruences, theorems of Fermat, Euler, and Wilson, and number theoretic functions. Emphasis on rigorous proof and mathematical communication. Formerly Math 345; students may not earn credit for both.

## MATH 3372. Combinatorics. Units: 3

Semester Prerequisite: MATH 2220 with a grade of C- or better; or MATH 2210, MATH 2265, and MATH 2372 with a grade of C- or better
Study of enumeration techniques, generating functions, recurrence relations, and principle of inclusion and exclusion. Formerly MATH 372; students may not earn credit for both.

## MATH 3460. Probability Theory. Units: 3

Semester Prerequisite: MATH 2320. Quarter Prerequisite: MATH 252
Introduction to counting techniques. Definition and properties of probability spaces. Random variables and their fundamental properties including densities, mass and distribution functions, means and variances. Theoretical properties of random variables including Chebyshev's inequality and the law of large numbers. Multivariate distributions with related concepts such as independence and joint distributions. Modeling of probabilistic processes including the use of appropriate software. Formerly MATH 465; students may not earn credit for both.

## MATH 3465. Computational Statistics. Units: 3

Semester Prerequisite: Math 2265, Math 3460
Essential concepts of computational statistics, including probability distributions, generating random variables, exploratory data analysis, Monte Carlo Methods for Inferential Statistics, data partitioning, probability density estimation, variance reduction techniques, bootstrapping, and optimization methods for maximum likelihood estimation. We will use the statistical software package R/R studio extensively in this course. May not be counted toward fulfilling requirements in the mathematics major.

## MATH 3480. Topics in History of Mathematics. Units: 3

Semester Prerequisite: Math 2220 with grade of C- or better. Quarter Prerequisite: Math 213 with grade of C- or better
Exploration of the historical and topical development of interconnected areas of mathematics, such as algebra, geometry and analysis. Discussion of the influence of a variety of cultures and societies on the development of mathematical ideas and discovery will be included. Formerly Math 480; students may not earn credit for both.

## MATH 3510. Topics in Mathematics. Units: 3

An in-depth study of selected areas of mathematics. Department consent required. May be repeated for credit with consent of department as topics change.

## MATH 3770. Introduction to Graph Theory. Units: 3

Semester Prerequisite: MATH 2320. Prerequisite: MATH 252
Introduction to graph theory and its applications. Topics will include properties of graphs, trees, directed graphs, graph isomorphisms, Eulerian and Hamiltonian graphs, planarity, and graph coloring problems. Formerly a topic in MATH 510.

## MATH 3951. Directed Study. Unit: 1

Reading and research in mathematics conducted under the direction of a faculty member. Consent of instructor and departmental approval of a written project proposal submitted on a standard application to be submitted in advance of the semester in which the course is to be taken. May be repeated for credit.

## MATH 3952. Directed Study. Units: 2

Reading and research in mathematics conducted under the direction of a faculty member. Consent of instructor and departmental approval of a written project proposal submitted on a standard application to be submitted in advance of the semester in which the course is to be taken. May be repeated for credit.

## MATH 3953. Directed Study. Units: 3

Reading and research in mathematics conducted under the direction of a faculty member. Consent of instructor and departmental approval of a written project proposal submitted on a standard application to be submitted in advance of the semester in which the course is to be taken. May be repeated for credit.

## MATH 4270. Differential Equations with Dynamical Systems II. Units: 3

Semester Prerequisite: Math 2270. Quarter Prerequisite: MATH 270
Theory of ordinary differential equations. Planar and higher order systems of equations with an emphasis on graphical and numerical techniques, as well as models and applications. Phase trajectory and stability analysis. Existence and uniqueness. Additional topics may include Laplace transformations, matrix methods, Gauss-Jordan and iterative techniques, series solutions, chaos theory. Formerly Math 470; students may not earn credit for both.

## MATH 4300. Real Analysis. Units: 4

Semester Prerequisite: MATH 2320 and MATH 3100. Quarter Prerequisite: MATH 252 and MATH 355
Properties of the set of real numbers and foundations of calculus: Equivalence relations, functions, cardinality, convergence of sequences and series of real numbers, topology of the real line, continuity, and differentiation. Emphasis on rigorous proof and mathematical communication. Professional mathematical typesetting and visualization technology. Formerly MATH 553 and part of MATH 355; students may not earn credit for both MATH 553 and MATH 4300.

## MATH 4320. Introduction to Actuarial Modeling. Units: 3

Semester Prerequisite: MATH 3460. Quarter Prerequisite: MATH 465
Introduction to modeling and actuarial methods that are useful in modeling short-term insurance coverage problems, including frequency, severity, and aggregate models.

## MATH 4360. Linear Statistical Models. Units: 3

Semester Prerequisite: MATH 3460 and Math 2265. Prerequisite: MATH 465 and MATH 262
Simple linear regression; multiple regression; analysis of variance; model validation and diagnostics. Additional topics may include ridge regression, LASSO, or logistic regression. Emphasis on computing and communication of statistical analyses.

## MATH 4455. Partial Differential Equations & Fourier Analysis. Units: 3

Semester Prerequisite: MATH 2270 and MATH 2320 with a C- or better. Quarter Prerequisite: MATH 270, MATH 252
Theory of partial differential equations and Fourier analysis, including graphical and numerical methods. Classification of partial differential equations. Fourier series and the Fourier transform, convergence properties and orthogonality. Topics may include the heat equation, Laplace's equation, boundary-value problems, applications of Fourier and Laplace transforms. Formerly parts of MATH 455 and MATH 570. Students may not earn credit for all three courses.

## MATH 4485. Differential Geometry. Units: 3

Semester Prerequisite: Math 2320 and Math 3100. Quarter Prerequisite: MATH 252, 331 and 355
An introduction to the differential geometry of curves and surfaces, including first and second fundamental forms, curvatures, geodesics, minimal surfaces, and Gauss-Bonnet Theorem. Formerly Math 485; students may not earn credit for both.

## MATH 4600. Theory of Rings and Fields. Units: 4

Semester Prerequisite: MATH 2320 and MATH 3100. Quarter Prerequisite: MATH 252 and MATH 345
An introduction to the study of rings and fields including the algebraic structure of the integers, polynomials, real and complex numbers, Gaussian integers, and matrix rings. Topics include ideals, integral domains, quotient rings, homomorphisms, and related theorems including the Fundamental Homomorphism Theorem. The course will conclude with an introduction to group theory. Formerly MATH 546 and part of 545. Students may not earn credit for both MATH 546 and MATH 4600.

## MATH 4900. Problem Solving and Mathematical Reasoning for Teachers II. Units: 4

Semester Prerequisite: MATH 2900 and MATH 3329
Continued development of problem solving skills and flexible thinking for future secondary teachers using multiple approaches and representations, mathematical habits of mind, and mathematical practices. Includes topics related to secondary mathematics and emphasizes communication, argumentation, mathematical structure and connections. Includes observations of secondary mathematics lessons via video with analysis of and reflection on effective teaching practices. Three hours in class and one hour online. Formerly MATH 399 and MATH 499. Students may not earn credit for MATH 499 and MATH 4900. Graded ABC/NC.

## MATH 5170. Complex Analysis. Units: 3

Semester Prerequisite: Math 2320 and Math 3100. Quarter Prerequisite: MATH 252 and 355
Theory of functions of a complex variable with an emphasis on definitions and proof. Complex numbers and their properties, analytic functions and the Cauchy-Riemann equations, elementary functions of a complex variable, integration of complex functions, the Cauchy integral theorem and its consequences, contour integrals, residues, transforms, and conformal mappings. Formerly Math 557; students may not earn credit for both.

## MATH 5300. Advanced Real Analysis. Units: 3

Semester Prerequisite: C- or better in MATH 4300. Quarter Prerequisite: C- or better in MATH 553
Further topics in the theory of single variable calculus: Continuation of differentiability, sequences of functions, series of functions and function approximation, uniform convergence, Riemann integration, pathological functions. May include selected topics from analysis as time permits, e.g., metric spaces, Lebesgue measure, normed linear spaces, historical developments. Emphasis on rigorous proof and mathematical communication. Professional mathematical typesetting and visualization technology. Formerly MATH 554; students may not earn credit for both.

## MATH 5310. Advanced Linear Algebra. Units: 3

Semester Prerequisite: Math 2310 and Math 3100. Quarter Prerequisite: MATH 331 and at least one of MATH 329, MATH 345, or MATH 355
Theoretical aspects of vector spaces, linear transformations, and inner product spaces that include linear independence, dimension, matrix representations, dual spaces, quadratic forms, spectral theory, and canonical forms. Emphasis on rigorous proof and mathematical communication. Professional mathematical typesetting and visualization technology. Formerly MATH 531; students may not earn credit for both.

## MATH 5360. Statistical Methods for Machine Learning. Units: 3

Semester Prerequisite: MATH 2265 - Statistics with Applications, MATH 4360 - Linear Statistical Models
In this class, we will explore and discuss statistical learning methods and their application to modern problems in science, industry, and society. Topics will include statistical learning, linear regression, classification, linear model selection, lasso and ridge regression, non-linear regression, and unsupervised learning. We will use the statistical software package R/R studio extensively in this course. May not be counted toward fulfilling requirements in the mathematics major.

## MATH 5510. Topics in Advanced Mathematics. Units: 3

Quarter Prerequisite: Senior or graduate standing
Study of selected areas of advanced mathematics. May be repeated for credit with consent of instructor as topics change.

## MATH 5529. Advanced Topics in Geometry. Units: 3

Semester Prerequisite: Math 2320 and Math 3329. Quarter Prerequisite: MATH 329, MATH 331 and MATH 355
Study and comparison of non-Euclidean geometries such as elliptical and hyperbolic geometries, with an emphasis on transformations. Non-Euclidean analogues of classical theorems in Euclidean geometry. Formerly Math 529; students may not earn credit for both.

## MATH 5550. Introduction to Topology. Units: 3

Semester Prerequisite: C- or better in MATH 4300. Quarter Prerequisite: C- or better in MATH 355
An introduction to topological spaces, including metric spaces. Concepts will include continuous functions, homeomorphisms, and homotopies between topological spaces, notions of connectedness and compactness, Hausdorff spaces, product spaces, the quotient topology, and the fundamental group. Formerly MATH 555. Students may not earn credit for both.

## MATH 5565. Mathematical Statistics. Units: 3

Semester Prerequisite: C- or better in MATH 2265 and MATH 3460. Quarter Prerequisite: C- or better in MATH 465
Likelihood ratio, estimators, distributions of estimators, theory of hypothesis testing; resampling methods; introduction to Bayesian methods. Formerly MATH 565. Students may not earn credit for both.

## MATH 5580. CSUSB to PhD Bridge. Units: 3

Semester Prerequisite: MATH 4300 or MATH 4600
Information about mathematics graduate school and tools to succeed in graduate school, with an emphasis on PhD-level work and programs. Activities may include independent investigation of advanced mathematics, locating professional funding and resources, preparing application materials, designing and delivering presentations, attendance at local seminars and research conferences, exploration of government and industry careers that use mathematics and statistics, and learning how to create a supportive research community. This is not a GRE preparation course. Formerly a topic in MATH 5510. Graded CR/NR. Department consent required.

## MATH 5600. Group Theory. Units: 3

Semester Prerequisite: MATH 4600 with a grade of C- or better
A study of groups including symmetry groups, normal subgroups, isomorphisms, cosets, quotient groups, Sylow groups, and related theorems including Lagrange's Theorem, Cayley's Theorem, the Fundamental Theorem of Finite Abelian Groups. Formerly MATH 545; students may not earn credit for both.

## MATH 5900. Senior Seminar for Future Mathematics Educators. Units: 3

Semester Prerequisite: Senior standing, Math 4900, and either MATH 4300 or MATH 4600
Culminating experience in problem solving, reasoning, and communication for future secondary mathematics teachers. Student led presentations and discussions around topics in mathematics education. Each student will reflect on their own mathematical growth throughout their undergraduate program and make connections to content and practice standards within secondary mathematics. Formerly MATH 599, students may not earn credit for both. Graded ABC/NC.

## MATH 5951. Independent Study. Unit: 1

Semester Prerequisite: MATH 3100 and a minimum overall grade point average of a B or better. Quarter Prerequisite: MATH 345 or MATH 355, and a minimum overall grade point average of a B or better
An independent study course for junior or senior mathematics majors. Consent of instructor required and departmental approval of a written project proposal submitted in advance of the semester in which the course is to be taken. Repeatable for a maximum of three units; no more than three units of MATH 5951, MATH 5952, or MATH 5953 may be applied toward math elective credit for the degree.

## MATH 5952. Independent Study. Units: 2

Semester Prerequisite: MATH 3100 and a minimum overall grade point average of a B or better. Quarter Prerequisite: MATH 345 or MATH 355, and a minimum overall grade point average of a B or better
An independent study course for junior or senior mathematics majors. Consent of instructor required and departmental approval of a written project proposal submitted in advance of the semester in which the course is to be taken. No more than three units of MATH 5951, MATH 5952, or MATH 5953 may be applied toward math elective credit for the degree.

## MATH 5953. Independent Study. Units: 3

Semester Prerequisite: MATH 3100 and minimum overall grade point average of a B or better. Quarter Prerequisite: MATH 345 or MATH 355, and a minimum overall grade point average of a B or better
An independent study course for junior or senior mathematics majors. Consent of instructor required and departmental approval of a written project proposal submitted in advance of the semester in which the course is to be taken. No more than three units of MATH 5951, MATH 5952, or MATH 5953 may be applied toward math elective credit for the degree.

## MATH 6000. Communicating Mathematics. Units: 2

Semester Prerequisite: Admission to the MA program in Mathematics. Prerequisite: Admission to the MA program in Mathematics
Seminar focusing on effective and precise written and oral communication of mathematics. Students will become familiar with scientific word processing and presentation programs such as LaTex and Beamer, and will prepare an article and presentation in professional style. This course meets the Writing Requirement for Graduate Candidacy.

## MATH 6016. Graduate Algebra. Units: 4

Semester Prerequisite: Math 5600 and Admission the MA program in Mathematics. Quarter Prerequisite: MATH 546 and admission to the MA program

Continuation of Math 5600. Review of basic ring theory focusing on irreducibility and associated ideals, followed by fields and field extensions, Galois groups, solvability of groups and solvability of polynomials by radicals, and the Fundamental Theorem of Galois Theory. Formerly Math 616; students may not receive credit for both.

## MATH 6018. Analysis in Several Variables. Units: 4

Semester Prerequisite: Math 5300 and admission to the MA program in Mathematics. Quarter Prerequisite: MATH 553; either MATH 554, MATH 555, or MATH 557; and admission to the MA program

A rigorous development of the calculus of vector valued functions of several variables, including a theoretical development of the derivative and its applications, the Inverse and Implicit Function Theorems, a development of Riemann Integration, Fubini's Theorem, differential forms, change of variables in integration, and Stokes' Theorem. Additional topics may include but are not limited to: abstract measure theory, metric spaces, or an introduction to manifolds and differential geometry. Formerly Math 618; students may not receive credit for both.

## MATH 6110. Topics in Mathematics. Units: 3

Study of selected areas of advanced mathematics to be determined by the instructor. May be repeated for credit with department consent as topics change. There is no limit to the number of times this course may count towards the 6000-level elective requirement.

## MATH 6145. Problem Solving. Units: 4

Semester Prerequisite: Admission to the MA program. Quarter Prerequisite: MATH 329, MATH 331, MATH 345, MATH 355 and MATH 372

A problem solving seminar in the style of George Polya, presenting techniques for attacking and solving challenging problems in mathematics. A variety of problem solving heuristics will be introduced, with an emphasis on induction and analogy. After surveying problems in a variety of content areas (e.g. geometry, algebra, combinatorial reasoning, and number theory), one area of mathematics will then be investigated and explored at a deeper level, employing the students' new problem solving skills. Formerly Math 604; students may not receive credit for both.

## MATH 6178. Teaching Practicum. Units: 2

Semester Prerequisite: Admission to the MA program. Quarter Prerequisite: Admission to the MA program

Seminar on teaching methods for mathematics. It is strongly recommended that students have a teaching or tutoring position. Topics include active learning techniques, use of technology, and cognitive issues to look for, for example, proportional reasoning. Activities include readings and writings in mathematics pedagogy and learning community activities such as peer observations, lesson study, and class visits as available. Only one occurrence of Math 6178 may count toward the 6000 level elective requirement, however this course may be repeated for credit. Formerly Math 678. Students may receive credit for both, however only one may count toward the 6000 level elective requirement.

## MATH 6301. Algebra from a Teaching and Problem Solving Perspective. Units: 4

Semester Prerequisite: Admission to the MAT program and MATH 3100, or consent of instructor, MATH 4600 is recommended. Quarter Prerequisite: Admission to the MAT in Mathematics program and MATH 345, or consent of instructor

Algebraic thinking building from numerical reasoning, algebraic structures, and fundamental concepts of functions. Problem solving using multiple representations will be stressed throughout. Students will adapt methods from this course for implementation in a secondary classroom setting and submit a written reflection on their learning in the course. Formerly MATH 631. May not be taken for credit by students who have completed MATH 631.

## MATH 6302. Geometry from a Teaching and Problem Solving Perspective. Units: 4

Semester Prerequisite: Admission to the MAT program and MATH #transformation-geometry, or consent of instructor. Quarter Prerequisite: MATH 329 and admission to the MAT in Mathematics program, or consent of instructor

Development of geometric thinking, problem solving and proof with emphasis on Euclidean and transformational geometry. Geometric constructions using appropriate tools, including dynamic geometry software. Topics to include analytic geometry and concepts of trigonometry with applications. Students will adapt methods from this course for implementation in a secondary classroom setting and submit a written reflection on their learning in the course. Formerly MATH 632; may not be taken for credit by students who have completed MATH 632.

## MATH 6303. Advanced Concepts of Secondary Mathematics from a Teaching and Problem Solving Perspective I. Units: 4

Semester Prerequisite: Admission to the MAT program, MATH 2220 and either MATH 2310 or MATH 2320, or consent of instructor, Math 6301 and 6302 are recommended. Quarter Prerequisite: MATH 213, MATH 251, and admission to the MAT in Mathematics program, or consent of instructor

The first of two courses addressing concepts typically addressed in the fourth year of secondary mathematics, from an advanced perspective, with active learning teaching strategies. Topics to include the further development of algebra, geometry, and trigonometry leading to a problem based approach to calculus. Emphasis on the study and application of functions. Students will adapt methods from this course for implementation in a secondary classroom setting and submit a written reflection on their learning in the course. May not be taken for credit by students who have completed Math 633 and Math 634.

## MATH 6304. Advanced Concepts of Secondary Mathematics from a Teaching and Problem Solving Perspective II. Units: 4

Semester Prerequisite: Admission to the MAT program and either MATH 2265 or MATH 3460, or consent of instructor, Math 6301, 6302 and 6303 are recommended. Quarter Prerequisite: MATH 372 and admission to the MAT in Mathematics program, or consent of instructor

The second of two courses addressing concepts typically addressed in the fourth year of secondary mathematics, from an advanced perspective, with active learning teaching strategies. Topics to include further development of calculus, basic probability and descriptive and inferential statistics. Students will adapt methods from this course for implementation in a secondary classroom setting. Students will submit a written reflection on their learning in the course. May not be taken for credit by students who have completed Math 634 and Math 635.

## MATH 6309. MAT Candidates' Seminar. Units: 4

Semester Prerequisite: Advancement to Candidacy. Prerequisite: Advancement to Candidacy and approval of graduate program coordinator

Analysis and synthesis of research literature in secondary mathematics education. Problem solving in secondary school mathematics. Consent of graduate program coordinator required. Graded Credit/No Credit.

## MATH 6411. Operations Analysis. Units: 3

Semester Prerequisite: Admission to the MA program in National Security Studies

Scientific approach to the resolution of operational problems. Structure and function of models and decision strategy commonly used in national policy analysis including measures of effectiveness, uncertainty and the misuse of modeling. May not be counted toward fulfilling the requirements in either the MA or MAT in Mathematics programs. Formerly Math 611; students may not receive credit for both.

## MATH 6880. Data Science Capstone Project. Units: 4

Semester Prerequisite: Advancement to candidacy in the MS in Applied Data Science program

Culmination of the MS in Applied Data Science program. Work on real-world projects that emphasize preparation for professional practice. Demonstration of proficiency in presenting and documenting work and preparing a formal data science project report. Requires departmental approval of a written project proposal submitted in advance of the semester in which the course is to be taken. May not be taken for credit in the Mathematics MA program. Offered as CSE 6880 and MATH 6880. Students may not receive credit for both.

## MATH 6900. Comprehensive Exam Preparation in Elective Topics. Unit: 1

Semester Prerequisite: Advancement to candidacy

Semester Corequisite: Math 6916 and Math 6918

To be taken in the final semester of the program with Math 6916 and 6918, the objective of this course for the student is to prepare for the elective topic comprehensive exam; the scope of this exam is content from two elective courses the student has taken. This exam is administered by the student's faculty committee, which is generally expected to be the instructors from those elective courses the exam covers and one additional faculty of the student's choosing. Graded as CR when the exam is successfully passed, and RP otherwise. The exam may only be retaken once in the event it is not passed. Consent of instructor required. A written proposal must be submitted to the MA coordinator before the final week of classes in the semester preceding enrollment in Math 6900. This proposal must contain the date, time, and location of all comprehensive exams, it must also list the parameters of the Elective Topic Comprehensive Exam, and must have the approval of the instructors of the student's committee before submission to the MA coordinator for approval by the MA Committee.

## MATH 6916. Comprehensive Exam Preparation in Algebra. Unit: 1

Semester Prerequisite: Advancement to candidacy

Semester Corequisite: Math 6900 and Math 6918

To be taken in the final semester of the program with Math 6918 and Math 6900, the objective of this course for the student is to prepare for the Algebra Comprehensive Exam. Graded as CR when the exam is successfully passed, and RP otherwise. The exam may only be retaken only once in the event it is not passed. Consent of instructor required.

## MATH 6918. Comprehensive Exam Preparation in Analysis. Unit: 1

Semester Prerequisite: Advancement to candidacy

Semester Corequisite: Math 6916 and Math 6900

To be taken in the final semester of the program with Math 6916 and Math 6900, the objective of this course for the student is to prepare for the Analysis Comprehensive Exam. Graded as CR when the exam is successfully passed, and RP otherwise. The exam may only be retaken only once in the event it is not passed. Consent of instructor required.

## MATH 6951. Graduate Independent Study. Unit: 1

Semester Prerequisite: Advancement to candidacy in the Mathematics MA or MAT program. Quarter Prerequisite: Advancement to candidacy in the Mathematics MA or MAT program; consent of the instructor and approval by the graduate committee

An independent study course for graduate students in mathematics. A written proposal for independent study must be submitted to the graduate committee before the final week of classes in the term preceding the term of enrollment in independent study. A maximum of four units of Graduate Independent Study (MATH 6951, 6952, 6953 or 6954) may count towards the 6000-level elective requirement in the Mathematics MA program. Department consent required.

## MATH 6952. Graduate Independent Study. Units: 2

Semester Prerequisite: Advancement to candidacy in the Mathematics MA or MAT program. Quarter Prerequisite: Advancement to candidacy in the MA or MAT in Mathematics program; a grade point average of at least 3.5 in courses in the program, consent of the instructor and approval by the graduate committee

An independent study course for graduate students in mathematics. A written proposal for independent study must be submitted to the graduate committee before the final week of classes in the term preceding the term of enrollment in independent study. A maximum of four units of Graduate Independent Study (MATH 6951, 6952, 6953 or 6954) may count towards the 6000-level elective requirement in the Mathematics MA program. Formerly MATH 695B. Department consent required.

## MATH 6953. Graduate Independent Study. Units: 3

Semester Prerequisite: Advancement to candidacy in the Mathematics MA or MAT program. Quarter Prerequisite: Advancement to candidacy in the MA or MAT in Mathematics program, a grade point average of at least 3.5 in courses in the program, consent of the instructor and approval by the graduate committee

An independent study course for graduate students in mathematics. A written proposal for independent study must be submitted to the graduate committee before the final week of classes in the term preceding the term of enrollment in independent study. A maximum of four units of Graduate Independent Study (MATH 6951, 6952, 6953 or 6954) may count towards the 6000-level elective requirement in the Mathematics MA program. Formerly MATH 695C. Department consent required.

## MATH 6954. Graduate Independent Study. Units: 4

Semester Prerequisite: Advancement to candidacy in the Mathematics MA or MAT program. Quarter Prerequisite: Advancement to candidacy in the MA or MAT in Mathematics program, a grade point average of at least 3.5 in courses in the program, consent of the instructor and approval by the graduate committee

An independent study course for graduate students in mathematics. A written proposal for independent study must be submitted to the graduate committee before the final week of classes in the term preceding the term of enrollment in independent study. Students will be required to give an oral presentation of their work to the mathematics department to count this course towards the 6000-level elective requirement in the Mathematics MA program. A maximum of four units of Graduate Independent Study (MATH 6951, 6952, 6953 or 6954) may count towards the 6000-level elective requirement in the Mathematics MA program. Formerly MATH 695D. Department and College consent required.

## MATH 6963. Master of Arts in Teaching Mathematics Project. Units: 3

Semester Prerequisite: Advancement to candidacy in the Mathematics MAT program. Quarter Prerequisite: Graduate standing, consent of the instructor, approval of the thesis proposal by the graduate committee and submission of at least three contributions to the Assessment Portfolio

Written project and oral presentation of the project to the department of Mathematics. A written project proposal following departmental guidelines must be submitted to the graduate committee before the last week of classes in the term preceding enrollment in MATH 6963. Instructor consent required. May not be counted toward fulfilling the requirements of the Mathematics MA. Formerly Math 699. Graded Credit/No Credit.

## MATH 6972. Graduate Thesis I. Units: 2

Semester Prerequisite: advancement to candidacy (and GPA greater than or equal to 3.25 in the MA program). Quarter Prerequisite: Graduate standing, consent of instructor, approval of the project proposal by the graduate committee and approval of at least five contributions to the assessment portfolio of the seven listed under 6b and 6c in the requirements for graduation

Thesis preparation. Objectives: assemble thesis committee and submit thesis proposal to the MA Committee. Consent of thesis advisor. A written course proposal must be submitted to the MA coordinator before the final week of classes of the semester preceding enrollment in Math 6972. Graded as CR upon completion of work, RP until that time. Formerly Math 696; students may not receive credit for both.

## MATH 6974. Graduate Thesis II. Units: 4

Semester Prerequisite: A GPA in the MA program of 3.25 or higher, Math 6972, advancement to candidacy, and approval of thesis proposal produced in Math 6972 by the MA Committee. Quarter Prerequisite: MATH 696 and consent of instructor

Continuation of Math 6972. Objectives: successful completion and defense of the thesis. Graded CR upon successful completion of the thesis and acceptance of it by Graduate Studies, graded RP until then. Consent of Department required. Formerly Math 697; students may not receive credit for both.

## MATH 6980. MAT Comprehensive Examination. Units: 0

Semester Prerequisite: advancement to candidacy in the Mathematics MAT program, completion of program coursework, and approval of the graduate coordinator. Prerequisite: advancement to candidacy in the Mathematics MAT program, completion of program coursework, and approval of the graduate coordinator

An assessment of the student's ability to integrate the knowledge of the area, show critical and independent thinking and demonstrate mastery of the subject matter. Examination topics to include the content of MATH 6301, 6302, 6303 and 6309. Candidates for the Mathematics MAT may enroll no earlier than the last term in which MAT coursework is taken. May not be counted towards the requirements of the Mathematics MA degree. Graded credit/no credit.

## MATH 6981. MA Comprehensive Examination. Units: 0

Semester Prerequisite: Advancement to candidacy in the Mathematics MA program and expected completion of program coursework in the semester enrolled

An assessment of the student's ability to integrate the knowledge of the area, show critical and independent thinking and demonstrate mastery of the subject matter. Students should enroll in this course in the expected final semester of the program concurrent with Math 6900, 6916, and 6918. Approval of the graduate coordinator required. Graded credit/no credit. The grade of Credit is given when all three MA Comprehensive Exams are passed.

## MATH 6990. Continuous Enrollment for Graduate Candidacy Standing. Units: 0

Quarter Prerequisite: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in a Continuous Enrollment for Graduate Candidacy Standing course each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. Continuous Enrollment for Graduate Candidacy Standing is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

## MATH 6991. Continuous Enrollment for Graduate Candidacy Standing. Unit: 1

Quarter Prerequisite: Advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in a Continuous Enrollment for Graduate Candidacy Standing course each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. Continuous Enrollment for Graduate Candidacy Standing is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

## MATH 6992. Continuous Enrollment for Graduate Candidacy Standing. Units: 2

Quarter Prerequisite: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in a Continuous Enrollment for Graduate Candidacy Standing course each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. Continuous Enrollment for Graduate Candidacy Standing is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

## MATH 6993. Continuous Enrollment for Graduate Candidacy Standing. Units: 3

Quarter Prerequisite: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in a Continuous Enrollment for Graduate Candidacy Standing course each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. Continuous Enrollment for Graduate Candidacy Standing is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

## MATH 6994. Continuous Enrollment for Graduate Candidacy Standing. Units: 4

Quarter Prerequisite: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in a Continuous Enrollment for Graduate Candidacy Standing course each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. Continuous Enrollment for Graduate Candidacy Standing is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

## MATH 6995. Continuous Enrollment for Graduate Candidacy Standing. Units: 5

Quarter Prerequisite: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in a Continuous Enrollment for Graduate Candidacy Standing course each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. Continuous Enrollment for Graduate Candidacy Standing is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

## MATH 6996. Continuous Enrollment for Graduate Candidacy Standing. Units: 6

Quarter Prerequisite: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in a Continuous Enrollment for Graduate Candidacy Standing course each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. Continuous Enrollment for Graduate Candidacy Standing is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.