MATHEMATICS (MATH)

See Course Description Symbols and Terms (https://catalog.csuchico.edu/academic-standards-policies/course-description-symbols-terms/) for an explanation of course description terminology and symbols, the course numbering system, and course credit units.

- In certain courses, at the discretion of the instructor, you may be required to buy a computer program and/or graphing calculator.
- Enrollment in any mathematics course requires a grade of C- or higher in all prerequisite courses or their transfer equivalents.

MATH 001L Support Course for MATH 101 **1 Unit**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready with Support or ALEKS PPL proctored assessment score of 45 or lower.
Corequisites: MATH 101.
Typically Offered: Fall and spring
This required corequisite course supports mathematical skills and knowledge used in MATH 101, Patterns of Mathematical Thought. May include study skill development, quantitative reasoning practice, and hands-on activities. 1 hour discussion. (022672)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 1 unit
Course Attributes: Pre-Collegiate

MATH 005L Support Course for MATH 105 **1 Unit**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready with Support or ALEKS PPL proctored assessment score of 45 or lower.
Corequisites: MATH 105.
Typically Offered: Fall and spring
This required corequisite course supports mathematical skills and knowledge used in MATH 105, Introduction to Statistics. May include study skill development, quantitative reasoning practice, and hands-on activities. 3 hours laboratory. (005498)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 1 unit
Course Attributes: Pre-Collegiate

MATH 007L Support Course for MATH 107 **1 Unit**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready with Support or ALEKS PPL proctored assessment score of 45 or lower.
Corequisites: MATH 107.
Typically Offered: Fall and spring
This required corequisite course supports mathematical skills and knowledge used in MATH 107, Finite Mathematics. May include study skill development, quantitative reasoning practice, and hands-on activities. 3 hours laboratory. (022081)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 1 unit
Course Attributes: Pre-Collegiate

MATH 010L Support Course for MATH 110 **1 Unit**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready with Support or ALEKS PPL proctored assessment score of 45 or lower.
Corequisites: MATH 110.
Typically Offered: Fall and spring
This required corequisite course supports mathematical skills and knowledge used in MATH 110, Concepts and Structures of Mathematics. May include study skill development, quantitative reasoning practice, and hands-on activities. 3 hours laboratory. (022082)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 1 unit
Course Attributes: Pre-Collegiate

MATH 016L Support Course for MATH 116 **1 Unit**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready with Support or ALEKS PPL proctored assessment score of 45 or lower.
Corequisites: MATH 116.
Typically Offered: Fall and spring
This required corequisite course supports mathematical skills and knowledge used in MATH 116, College Algebra. May include study skill development, quantitative reasoning practice, and hands-on activities. STEM pathway. 3 hours laboratory. (022083)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 1 unit
Course Attributes: Pre-Collegiate

MATH 101 Patterns of Mathematical Thought **3 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready or ALEKS PPL proctored assessment score of 46 or higher, or GE Mathematical Concepts Quantitative Reasoning Ready with Support and enrollment in MATH 001L.
Typically Offered: Fall and spring
An informal approach to mathematics designed to bring an appreciation and workable knowledge of the subject to non-majors. Not acceptable for a mathematics major or minor. 1 hour discussion, 2 hours lecture. (005514)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 105 Introduction to Statistics **3 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready or ALEKS PPL proctored assessment score of 46 or higher, or GE Mathematical Concepts Quantitative Reasoning Ready with Support and concurrent enrollment in MATH 005L.
Typically Offered: Fall and spring
Summary of numerical data, distributions, linear regression, and introduction to statistical inference. Statistical software is used. 1.5 hours discussion, 1.5 hours lecture. (005501)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 107 Finite Mathematics for Business **3 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready or ALEKS PPL proctored assessment score of 46 or higher, or GE Mathematical Concepts Quantitative Reasoning Ready with Support and concurrent enrollment in MATH 007L.
Typically Offered: Fall and spring
Solutions to systems of linear equations, matrices, linear programming, combinatorics, probability, binomial and normal distributions. 1.5 hours discussion, 1.5 hours lecture. (005521)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 108 Statistics of Business and Economics **3 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready or ALEKS PPL proctored assessment score of 46 or higher.
Typically Offered: Fall and spring
Descriptive statistics, sampling theory, statistical inference and tests of hypotheses, analysis of variance, chi-square tests, simple regression and correlation, and multiple regression and correlation. 1.5 hours discussion, 1.5 hours lecture. (001042)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 109 Survey of Calculus **4 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready and ALEKS PPL proctored assessment score of 76 or higher; or MATH 116, MATH 016L, and MATH 118 all with a B or higher; or MATH 119.
Typically Offered: Fall and spring
This course covers the fundamental concepts and techniques of differential and integral calculus with an introduction to differential equations. Emphasis on applications from the life sciences. This course is not intended for majors in mathematics, physics, chemistry, or engineering. No credit for students with credit in MATH 120. 4 hours discussion. (005512)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 110 Concepts and Structures of Mathematics **3 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready or ALEKS PPL proctored assessment score of 46 or higher, or GE Mathematical Concepts Quantitative Reasoning Ready with Support and concurrent enrollment in MATH 010L.
Typically Offered: Fall and spring
Structure of the real number system, operations on real numbers, number theory. Not acceptable for a mathematics major or minor. 3 hours discussion. (005522)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 116 College Algebra **4 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready with Support and concurrent enrollment in MATH 016L or ALEKS PPL proctored assessment score of 45 or lower.
Typically Offered: Fall and spring
This course covers advanced algebra concepts beyond the scope of Intermediate Algebra. The topics include algebraic simplifying, conics, theory and solution of equations and inequalities, systems of equations, linear functions, exponential and logarithmic functions, polynomial and rational functions, binomial expansion, and partial fractions. STEM pathway. 4 hours lecture. (021954)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 117 Hands-On Lab, Mathematics **2 Units**
Prerequisite: MATH 110.
Corequisites: MATH 210 or faculty permission.
Typically Offered: Fall and spring
The Hands-On Lab for Mathematics provides a rich, sustained, and guided teaching experience for undergraduate students preparing to be elementary or middle school teachers. By developing, refining, and repeatedly teaching a lesson aligned to California mathematics standards, prospective teachers gain insights into the complexities of teaching mathematics content. In addition, prospective teachers engage in Lesson Study with the teachers for these children, thus acquiring experience in a collegial relationship with practicing professionals. 2 hours seminar. (020430)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 118 Trigonometry **3 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready or ALEKS PPL proctored assessment score of 46 or higher.
Typically Offered: Fall and spring
Trigonometric functions, graphs, identities and conditional equations, logarithms, solutions of triangles, and complex numbers. STEM Pathway. 3 hours discussion. (005500)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 119 Precalculus Mathematics **4 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready and ALEKS PPL proctored assessment score of 61 or higher; or MATH 118 (may be taken concurrently).
Typically Offered: Fall and spring
Functions and graphs, including polynomial, rational, exponential, logarithmic, and trigonometric functions. Systems of equations and inequalities, polar and parametric equations, complex numbers, and analytic trigonometry. STEM Pathway. 4 hours discussion. (005504)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 119X Precalculus Problem Session **1 Unit**
Prerequisite: Faculty permission.
Corequisites: MATH 119.
Typically Offered: Fall and spring
Designed to supplement MATH 119 with additional applications. Provides the student with the opportunity for additional assistance in developing problem-solving abilities. 3 hours independent study. (005505)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 120 Analytic Geometry and Calculus **4 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready and ALEKS PPL proctored assessment score of 76 or higher; or MATH 116, MATH 016L, and MATH 118 all with a B or higher; or MATH 119.
Typically Offered: Fall and spring
Limits and continuity. The derivative and applications to related rates, maxima and minima, and curve sketching. Transcendental functions. An introduction to the definite integral and area. STEM Pathway. 4 hours discussion. (005506)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 120X Calculus Problem Session **1 Unit**
Prerequisite: Faculty permission.
Corequisites: MATH 120.
Typically Offered: Fall and spring
Designed to supplement MATH 120 with additional applications of introductory calculus. Provides the student with the opportunity for additional assistance in developing problem-solving abilities. 3 hours independent study. (005510)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 121 Analytic Geometry and Calculus **4 Units**
Prerequisite: MATH 120.
Typically Offered: Fall and spring
The definite integral and applications to area, volume, work, differential equations, etc. Sequences and series, vectors and analytic geometry in 2 and 3-space, polar coordinates, and parametric equations. 4 hours discussion. (005507)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 121X Calculus Problem Session **1 Unit**
Prerequisite: Faculty permission.
Corequisites: MATH 121.
Typically Offered: Fall and spring
Designed to supplement MATH 121 with additional applications and expanded explanations of concepts encountered in second-semester calculus. Provides the student with the opportunity for additional assistance in coming to an understanding of the concepts of calculus. 3 hours independent study. (005511)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 125 Advanced Number and Operation **3 Units**
Prerequisite: MATH 118 or MATH 119 (may be taken concurrently).
Typically Offered: Fall only
Investigate number and operation through calculation and abstraction, find patterns and relationships through computation, develop and test mathematical conjectures, and develop an appreciation of proof and an ability to make mathematical arguments. Basic concepts from Number Theory are explored, culminating in proof of the Fundamental Theorem of Arithmetic and related theorems in other number sets. 3 hours discussion. (021846)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 130 Introduction to R **1 Unit**
Typically Offered: Fall and spring
This accelerated short course is designed as a primer to get the complete novice up and running with basic knowledge of how to use the statistical programming language R. The target audience is anyone who wants to become the boss of their data and conduct analyses. The course covers getting data into R, manipulating data into an analyzable format, and creating informative plots. Emphasis is placed on reproducibility and literate programming. The course culminates with a data exploration project. This course requires the use of a laptop computer and appropriate software. Typically offered as 3 hour discussion for five weeks. 1 hour discussion. (021774)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 2 units
Course Attributes: Lower Division; Laptop required, see department for details.

MATH 131 Introduction to Python **1 Unit**
Typically Offered: Fall and spring
This accelerated short course is designed as a primer to get the complete novice up and running with basic knowledge of how to use the programming language Python. The target audience is anyone who wants to become the boss of their data and conduct analyses. The course covers getting data into Python, manipulating data into an analyzable format, and creating informative plots. Emphasis is placed on reproducibility and literate programming. The course culminates with a data exploration project. This course requires the use of a laptop computer and appropriate software. 1 hour lecture. (022516)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 2 units
Course Attributes: Lower Division; Laptop required, see department for details.

MATH 185 Data Analytics for Social Good **3 Units GE**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning Ready or ALEKS PPL assessment score of 46 or higher.
Typically Offered: Fall and spring
This course introduces harnessing the power of data to intelligently cope with the requirements of citizenship, employment, and family to be prepared for a healthy, happy, and productive life. Students practice collecting data into a usable form, visualizing large data sets to discover patterns, representing data in a meaningful way, exploring varying interpretations of the data and results, and discussing potential for misuse and abuse. This course promotes critical reflection on the ethical, social, cultural, and political dimensions of data and provides hands-on experience with both spreadsheets and the programming language R. No prior programming experience is expected. 1 hour activity, 2 hours lecture. (022285)
General Education: Mathematical Concepts/QR (2)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division; Laptop required, see department for details.

MATH 195 Project MATH Seminar Year 1 **1 Unit**
Typically Offered: Fall and spring
The Project M.A.T.H. Seminar - Year 1 is a biweekly seminar for students in their first year of Project M.A.T.H., an innovative program for students interested in becoming secondary mathematics teachers. Students work with mentor teachers, prepare and present lessons, and participate in a structured early field experience. Completion of the seminar series satisfies the Credential Program's Early Field Experience requirement. 3 hours laboratory. (020431)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 2 units
Course Attributes: Lower Division

MATH 198 Special Topics **1-3 Units**
Prerequisite: GE Mathematical Concepts/Quantitative Reasoning (2) Ready.
Typically Offered: Fall and spring
This course is for special topics offered for 1.0-3.0 units. Typically the topic is offered on a one-time-only basis and may vary from term to term and be different for different sections. See The Class Schedule for the specific topic being offered. 0 hours discussion. (005528)
Grade Basis: Graded
Repeatability: You may take this course more than once
Course Attributes: Lower Division

MATH 199 Special Problems **1-3 Units**
Typically Offered: Fall and spring
This course is an independent study of special problems offered for 1.0-3.0 units. 9 hours supervision. (020782)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Lower Division

MATH 210 Concepts and Structures of Mathematics **3 Units**
Prerequisite: MATH 110.
Typically Offered: Fall and spring
Problem-solving, probability and statistics, measurement and the metric system, geometry. Not acceptable for a mathematics major or minor. 3 hours discussion. (005523)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 217 Discrete Mathematics **3 Units**
Prerequisite: GE Mathematical Concepts/Quantitative Reasoning (2) Ready, CSCI 111 with a grade of C- or higher (may be taken concurrently), MATH 119 (or equivalent).
Typically Offered: Fall and spring
Offers an intensive introduction to discrete mathematics as used in computer science. Topics include sets, relations, propositional and predicate logic, basic proof methods including mathematical induction, digital logic circuits, complexity of algorithms, elementary combinatorics, and solving linear recurrence relations. 3 hours discussion. (005550)
Cross listing(s): CSCI 217
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 220 Analytic Geometry and Calculus **4 Units**
Prerequisite: MATH 121.
Typically Offered: Fall and spring
Vector functions and space curves. Functions of several variables, partial derivatives, and multiple integrals. Vector calculus line integrals, surface integrals, divergence/curl, Green's Theorem, Divergence Theorem, and Stokes' Theorem. 4 hours discussion. (005508)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 220X Calculus Problem Session **1 Unit**
Corequisites: MATH 220.
Typically Offered: Fall and spring
Designed to supplement MATH 220 with broader and deeper applications of calculus, providing students with opportunities for additional problem-solving skill building. Twenty hours activity minimum for credit, but 40 hours are available to students. 3 hours independent study. (020358)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 225 Algebra Functions, Real and Complex Number Systems **3 Units**
Prerequisite: MATH 125.
Typically Offered: Spring only
This course focuses on developing your abilities in making sense of algebraic manipulation in the context of functions, polynomial rings, and matrices. The course and the classroom are structured as a supportive, collaborative learning environment in which mathematical discourse is valued and exploration encouraged. You will investigate algebra and polynomials through calculation and abstraction, find patterns and relationships through computation, develop and test mathematical conjectures, and develop an appreciation of proof and an ability to construct mathematical arguments. More advanced concepts from Number Theory are explored, culminating in proofs of the Unique Prime Factorization Theorem and the Division Algorithm for different rings. 3 hours discussion. (021953)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 230 An Introduction to Computational Mathematics 3 Units
Prerequisite: MATH 121, no previous computer experience required.
Typically Offered: Fall only
An introduction to the use of mathematical computer software. This course provides an introduction to a programming environment, preparing math majors to use computers to explore and solve varied math problems. The software used in this class depends on the instructor and may be chosen from Mathematica, GP/PARI, GAP, SAS, R, etc. This course satisfies the computer literacy requirement for mathematics majors. 3 hours discussion. (005526)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 9 units
Course Attributes: Lower Division

MATH 235 Elementary Linear Algebra 3 Units
Prerequisite: MATH 120.
Typically Offered: Fall and spring
Matrices, determinants, cartesian n-space (basis and dimension of a subspace, rank, change of basis), linear transformations, eigenvalues. Numerical problems will be emphasized. 3 hours discussion. (005553)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 241 Secondary Math Early Field Experience 1 Unit
Typically Offered: Fall and spring
This seminar and the associated CAVE field experience give prospective teachers early exposure to issues relevant to the profession of teaching secondary mathematics. In particular, the experience helps these future teachers develop a deeper understanding of the K-12 mathematics curriculum, understand connections between their university subject matter preparation and K-12 academic content, and reflect on developmental and social factors that affect K-12 students' learning of mathematics. 1 hour seminar. (020432)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 260 Elementary Differential Equations 4 Units
Prerequisite: MATH 121.
Typically Offered: Fall and spring
First order separable, linear, and exact equations; second order linear equations, Laplace transforms, series solutions at an ordinary point, systems of first order linear equations, and applications. 4 hours discussion. (005509)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Lower Division

MATH 260X Elementary Differential Equations Problem Session 1 Unit
Corequisites: MATH 260.
Typically Offered: Fall and spring
Designed to supplement MATH 260 with broader and deeper applications of differential equations, providing the student with opportunities for additional problem-solving skills. A minimum of 20 hours of activity are required to earn credit for the class; forty hours are available. 3 hours independent study. (020315)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Lower Division

MATH 290 Mathematics and Statistics Tutoring 1 Unit
Corequisites: Concurrent enrollment in a course offered through the Dept of Mathematics Statistics at CSU, Chico.
Typically Offered: Fall and spring
This course provides supplemental mathematics statistics tutoring. 3 hours independent study. (020823)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 8 units
Course Attributes: Lower Division

MATH 295 Project MATH Seminar Year 2 1 Unit
Prerequisite: MATH 195.
Typically Offered: Fall and spring
The Project M.A.T.H. Seminar - Year 2 is the continuation of a biweekly seminar for students in Project M.A.T.H., an innovative program for students interested in becoming secondary mathematics teachers. Students work with mentor teachers, prepare and present lessons, and participate in a structured early field experience. They also take on a leadership role in the seminar. Completion of the seminar series satisfies the Credential Program's Early Field Experience requirement. 3 hours laboratory. (020433)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 2 units
Course Attributes: Lower Division

MATH 298 Special Topics 1-3 Units
Typically Offered: Inquire at department
This course is for special topics offered for 1.0 - 3.0 units. Typically the topic is offered on a one-time-only basis and may vary from semester to semester and be different for different sections. See the class schedule for the specific topic being offered. 0 hours supervision. (021615)
Grade Basis: Graded
Repeatability: You may take this course more than once
Course Attributes: Lower Division

MATH 299 Special Problems 1-3 Units
Prerequisite: Faculty permission.
Typically Offered: Inquire at department
This course is an independent study of special problems offered for 1.0-3.0 units. You must register directly with a supervising faculty member. 0 hours supervision. (021629)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Lower Division

MATH 300 Undergraduate Mathematics Seminar **2 Units**
Prerequisite: GE Mathematical Concepts/Quantitative Reasoning (2) Ready.
Typically Offered: Fall and spring
This course exposes students to mathematics not normally covered in regular curriculum. Guest speakers are drawn from the ranks of our faculty, including other disciplines, our students, and industry. Talks are interactive, participatory, and fun. There is no prerequisite, except an interest in interesting mathematics. Topics typically include selections from number theory, math education, statistics, problem solving, undergraduate research, calculus, differential equations, spatial and planar geometry, probability, computer applications, mathematical operations, modeling, topology, trigonometry, metric measurements, elliptical curves, and bubbles, among others. This exposure broadens students' horizons and expands their curiosity in hopes that they will explore mathematics beyond the required courses. 2 hours lecture. (021647)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 8 units
Course Attributes: Upper Division

MATH 301 Mathematics for Teaching Elementary/Middle School I **3 Units**
Prerequisite: GE Mathematical Concepts Quantitative Reasoning (2).
Typically Offered: Fall and spring
This is the first course in a sequence of specialized mathematics courses for future elementary and middle school teachers. Students study mathematical concepts using multiple perspectives, strategies, and representations appropriate for elementary and middle school classrooms. Topics include number systems and operations. Not acceptable for a mathematics major or minor. 3 hours discussion. (022773)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 303 Mathematics for Teaching Elementary/Middle School II **4 Units**
Prerequisite: MATH 301.
Typically Offered: Fall and spring
This is the second course in a sequence of specialized mathematics courses for future elementary and middle school teachers. Students study mathematical concepts using multiple perspectives, strategies, and representations appropriate for elementary and middle school classrooms. Topics include proportional reasoning, geometry, measurement, and data. Not acceptable for a mathematics major or minor. 4 hours discussion. (022774)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Upper Division

MATH 305 Conceptual and Practical Statistics **3 Units**
Prerequisite: MATH 120 or MATH 109 (may be taken concurrently).
Typically Offered: Spring only
Design of statistical experiments, graphing, sampling techniques, probability, and common probability distributions will be discussed, with an emphasis on practical applications. Uses and misuses of statistics, misrepresentation of data, and proper and improper statistical analyses will be discussed. 3 hours discussion. (005532)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 310 Patterns and Structures in Mathematics **3 Units**
Prerequisite: MATH 110; MATH 210 or MATH 225.
Typically Offered: Fall and spring
Builds upon student's understanding of numbers and operations to develop their algebraic and proportional reasoning. Probability viewed as an application of proportional reasoning. Foundational statistics is also covered. Overall focus on developing a deep understanding of mathematics that is relevant to the teaching of Kindergarten-8th grade. Not acceptable for a mathematics major or minor except the Foundational Math Education option and Math Education minor. 3 hours discussion. (005542)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 311 Mathematics for Teaching Middle School **3 Units**
Prerequisite: MATH 303.
Typically Offered: Spring only odd years
This is a specialized mathematics course for future middle school teachers. Students study mathematical concepts using multiple perspectives, strategies, and representations appropriate for middle school classrooms. Topics include transformational geometry, three-dimensional geometry, integer operations, linear and non-linear functions, and the Pythagorean Theorem. Not acceptable for a mathematics major or minor other than the mathematics education minor. 3 hours discussion. (005543)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 314 Probability and Statistics for Science and Technology **4 Units**
Prerequisite: MATH 121; and one of the following: CIVL 205, CSCI 111, MATH 130 (may be taken concurrently), MATH 230, or MECH 208.
Typically Offered: Fall and spring
Basic concepts of probability and statistics with emphasis on models used in science and technology. Probability models for statistical estimation and hypothesis testing. Confidence limits. One- and two-sample inference, simple regression, one- and two-way analysis of variance. Credit cannot be received for both MATH 314 and MATH 315. 4 hours discussion. (005533)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Upper Division; Laptop required, see department for details.

MATH 315 Applied Statistical Methods I **3 Units**
Prerequisite: MATH 105, MATH 109, MATH 119, or MATH 120.
Typically Offered: Fall and spring
Single and two sample inference, analysis of variance, multiple regression, analysis of co-variance, experimental design, repeated measures, nonparametric procedures, and categorical data analysis. Examples are drawn from biology and related disciplines. The statistical programming language R is used. Appropriate for biology, agriculture, nutrition, psychology, social science and other majors. 3 hours discussion. (005568)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 317 Cryptography **4 Units**
Prerequisite: CSCI 111; MATH 217 or MATH 330W.
Typically Offered: Spring only
This is the first course in cryptography with an emphasis on public key cryptosystems, digital signature schemes, and the underlying mathematical principles on which they are based. Students implement algorithms and solve problems in programming-based assignments. Some time is devoted to getting familiar with the Python programming language and the SageMath Software system. 4 hours discussion. (022044)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Upper Division

MATH 318 Topological Data Analysis **3 Units**
Prerequisite: MATH 217 or MATH 330W; CSCI 111 or faculty permission.
Typically Offered: Spring only odd years
In this course students use the tools of topology to study data sets in terms of their shape. Students become familiar with the basics of topology, and master a subset of algorithms for computing Betti number, topological persistence, homology cycles, Reeb graphs, and Laplace spectra. Students become familiar with designing algorithms for problems in applications dealing with data, and how to research the background of a topic in data analysis or machine learning. 3 hours discussion. (022453)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 330W Methods of Proof (W) **3 Units W**
Prerequisite: GE English Composition (1A) and MATH 121.
Typically Offered: Fall and spring
A survey of elementary principles of logic, emphasizing the nature of proof. Standard methods of proof will be illustrated with examples from various branches of mathematics, including set theory and the theory of functions and relations. Other possible sources of examples include calculus, number theory, theory of equations, and topology of the real line. 3 hours seminar. (005530)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Writing Course

MATH 333 History of Mathematics **3 Units**
Prerequisite: MATH 121; MATH 220 or MATH 225; and at least one upper division mathematics course. Recommended: MATH 330W.
Typically Offered: Spring only
Study of the historical development of mathematics, with particular emphasis on the relationship between mathematics and society. 3 hours discussion. (005531)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 337 Introduction to the Theory of Numbers **3 Units**
Prerequisite: MATH 121, MATH 330W.
Typically Offered: Fall only
Basic properties of the integers, division algorithm, fundamental theorem of arithmetic, number-theoretic functions, Diophantine equations, congruences, quadratic residues, continued fractions. 3 hours discussion. (005585)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 341 Mathematics for Teaching Secondary School **3 Units**
Prerequisite: MATH 121 or MATH 303.
Typically Offered: Fall only
This is a course in specialized mathematics for future secondary single-subject mathematics teachers. The mathematical topics are discussed from various perspectives with an emphasis on understanding the investigations and connections that foster a robust understanding of secondary school mathematics for adolescent learners. Topics selected from algebra, coordinate geometry, functions, and modeling. 3 hours seminar. (005544)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 342 Math Topics for the Credential **3 Units**
Prerequisite: MATH 341.
Typically Offered: Spring only
This course focuses on having students examine mathematical pedagogy and the understanding and evaluations of students as mathematical learners as it analyzes secondary mathematics curriculum from an advanced standpoint. Students will have opportunities to be involved in the facilitation of mathematical learning. Topics include: history of mathematics education, contemporary mathematics curricula, problem solving, mathematical reasoning and methods of proof, mathematical learning theories, communication, assessment and collaborative learning communities. 3 hours discussion. (005545)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 344 Graph Theory **3 Units**
Prerequisite: MATH 121; CSCI 217, MATH 217, or MATH 330W.
Typically Offered: Fall only odd years
An introduction to graph theory and network theory. Directed graphs, trees, connectivity, duality, coloring, and planarity are studied both from a theoretical perspective as well as with respect to efficient algorithms. 3 hours discussion. (005591)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 346 College Geometry **3 Units**
Prerequisite: MATH 220 or MATH 225; MATH 330W.
Typically Offered: Spring only
An exploration of axioms and models for Euclidean and non-Euclidean geometries focusing on the independence of the Parallel Postulate. Additional topics will be chosen from Euclidean plane geometry, transformation geometry, and the geometry of polyhedra. 3 hours discussion. (005561)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 350 Introduction to Probability and Statistics **3 Units**
Prerequisite: MATH 121.
Typically Offered: Fall and spring
Probability theory and application, discrete and continuous random variables and their distribution, basic sampling distributions, theory and concepts of expectations and variance. Statistical software may be used. 3 hours discussion. (005534)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 351 Introduction to Probability and Statistics **3 Units**
Prerequisite: MATH 350.
Typically Offered: Spring only
Continuation of MATH 350. 3 hours discussion. (005535)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 360 Ordinary Differential Equations **3 Units**
Prerequisite: MATH 260.
Typically Offered: Spring only
Systems of first order linear equations, existence and uniqueness theorems, stability, Sturm separation theorems, power series methods. 3 hours discussion. (005538)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 361 Boundary Value Problems and Partial Differential Equations **3 Units**
Prerequisite: MATH 260.
Typically Offered: Fall only
Partial differential equations, separation of variables, orthogonal sets of functions, Sturm-Liouville problems, Fourier series, boundary value problems for the wave equation, heat equation, and Laplace equation; Bessel functions, Legendre polynomials. 3 hours discussion. (005540)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 385 Introduction to Data Science **3 Units**
Prerequisite: CSCI 111, MATH 130, or MATH 230; MATH 109 or MATH 120.
Typically Offered: Fall only
Data Science is the science of learning from data in order to gain useful predictions and insights. The course provides an overview of the wide area of data science, with a particular focus on the tools required to store, clean, manipulate, visualize, model, and ultimately extract information from various sources of data. Topics include the analytics life cycle, data integration and modeling in R/Python, relational databases and SQL, text processing and sentiment analysis, and data visualization. Emphasis is placed on reproducible research, code sharing, version control, and communicating results to a non-technical audience. 3 hours discussion. (021756)
Cross listing(s): CSCI 385
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 398 Special Topics in Math **1-3 Units**
Prerequisite: At least one 100- or 200-level mathematics course appropriate to the subject, faculty permission.
Typically Offered: Fall and spring
This course is for special topics offered for 1.0-3.0 units. Typically the topic is offered on a one-time-only basis and may vary from term to term and be different for different sections. See the Class Schedule for the specific topic being offered. 9 hours supervision. (005559)
Grade Basis: Graded
Repeatability: You may take this course more than once
Course Attributes: Upper Division

MATH 399 Special Problems **1-3 Units**
Typically Offered: Fall and spring
This course is an independent study of special problems offered for 1.0-3.0 units. You must register directly with a supervising faculty member. MATH 399 cannot be used to fulfill major requirements without prior approval of the advisor and department chair. 0 hours supervision. (005560)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Upper Division

MATH 401 CMP Institute - Summer 1 **2 Units**
Typically Offered: Summer session only
CMP Institute - Summer 1 2 hours discussion. (005578)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Upper Division

MATH 405 Cmp Institute-Sp **1 Unit**
Typically Offered: Spring only
1 hour lecture. (005552)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Upper Division

MATH 407 CMP Institute - Summer 2 **1 Unit**
Typically Offered: Summer session only
1 hour discussion. (005579)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 2 units
Course Attributes: Upper Division

MATH 417 Applied Linear Algebra for Computer Science **4 Units**
Prerequisite: CSCI 211 with a grade of C- or higher; or classified graduate standing.
Typically Offered: Spring only
In this course, linear algebra is studied from a computer science (CS) and algorithmic perspective, emphasizing its critical role in various CS domains. The course is centered around real-world CS applications and hands-on programming exercises. Students not only master the core concepts of vectors and matrices but also recognize their practical utility in contemporary computational challenges in CS. Throughout the course, students are exposed to a programming language of the instructor's choosing and use it to delve into an array of CS applications such as combinatorial optimization, image compression via principal component analysis (PCA), computer graphics, page rank algorithm, machine learning, and scientific visualization. 4 hours lecture. (022545)
Cross listing(s): CSCI 417
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Upper Division; Laptop required, see department for details.

MATH 420W Advanced Calculus (W) **3 Units W, GW**
Prerequisite: GE English Composition (1A), MATH 220, MATH 330W, upper-division standing.
Typically Offered: Fall and spring
Limits, continuity, uniform continuity, the definite integral, series, convergence, uniform convergence, and metric spaces. Differentiation and integration of functions of several variables. Transformation of multiple integrals. 3 hours discussion. (005575)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Writing Course; Graduation Writing Assessment Requirement Course

MATH 421 Advanced Calculus **3 Units**
Prerequisite: MATH 420W.
Typically Offered: Spring only even years
Continuation of MATH 420W. 3 hours discussion. (005576)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 425W Computational and Communication in Mathematical Modeling (W) **3 Units W, GW**
Prerequisite: GE English Composition (1A), completion of computer literacy requirement, MATH 225, MATH 235, MATH 330W, and upper-division standing.
Typically Offered: Fall only
In this course, intended for pre-service teachers, student experience mathematical modeling with content common in the secondary setting (algebra through calculus) as well as from their undergraduate coursework and develop and produce formal modeling reports. Students use technology to aid in exploring real-world circumstances, make sense of and analyze existing models, and develop their own mathematical models. 3 hours discussion. (021977)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Writing Course; Graduation Writing Assessment Requirement Course

MATH 428 Differential Geometry **3 Units**
Prerequisite: MATH 220, MATH 330W.
Typically Offered: Fall only odd years
The geometry of curves and surfaces in Euclidean 3-space. 3 hours lecture. (005566)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 435 Linear Algebra **3 Units**
Prerequisite: MATH 220, MATH 235, MATH 330W.
Typically Offered: Spring only even years
Vector spaces, linear operators, bilinear forms and scalar products, unitary spaces; matrix polynomials, eigenvalues, and Jordan normal form. 3 hours discussion. (005581)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 437 Topology **3 Units**
Prerequisite: MATH 220, MATH 330W.
Typically Offered: Fall only even years
Metric spaces, continuous functions, homeomorphisms, separation, and covering axioms, connectedness. 3 hours discussion. (005563)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 442 Mathematics and the Teaching of Mathematics **3 Units**
Prerequisite: MATH 342.
Typically Offered: Fall only
Completes a three course series, started with two semesters of Mathematics for the Credential, MATH 341 and MATH 342. Students compare instructional strategies and explore the role content and pedagogical content knowledge has in these strategies. Central to the class is a lesson study project which entails a cycle of lesson development, implementation, reflection and revision, and implementation again. Students concurrently enrolled in EDTE 535A, Teaching Practicum I for Blended Math Candidates, are able to implement their lesson as part of the practicum, and have a real context for the full content of the course. 3 hours lecture. (020978)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 449 Modern Algebra **3 Units**
Prerequisite: MATH 220, MATH 235, MATH 330W.
Typically Offered: Fall only
Introduction to basic algebraic structures such as groups, ring, and fields. The fundamental concepts of homomorphism, subgroup, normal subgroup and factor group of a group as well as subring, ideal and factor ring of a ring; permutation groups and matrix groups. 3 hours discussion. (005582)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 450 Computational Statistics **3 Units**
Prerequisite: MATH 220, MATH 350 or MATH 650. Strongly Recommended: MATH 235 or a similar exposure to Linear Algebra.
Typically Offered: Fall only
Continuation of MATH 350 with a strong focus on computational tools used to fit statistical models. Topics may include Bayesian statistics, Monte Carlo, Markov chain Monte Carlo, optimization expectation-maximization algorithms, matrix decompositions, variational inference, stochastic optimization, and neural networks. This course requires the use of a laptop computer and appropriate software such as R or Python. 3 hours discussion. (005562)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Laptop required, see department for details.

MATH 451 Modern Algebra II **3 Units**
Prerequisite: MATH 449.
Typically Offered: Spring only odd years
Continuation of MATH 449, topics may include group actions, the Sylow theorems, number fields, finite fields, algebraic extensions, field automorphisms, splitting fields of polynomials, Galois groups, and solvable groups. 3 hours discussion. (021971)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 456 Applied Statistical Methods II **3 Units**
Prerequisite: MATH 314 or MATH 315.
Typically Offered: Spring only
Advanced topics in applied statistics including multiple and logistic regression, multivariate methods, multi-level modeling, repeated measures, and others as appropriate. The statistical programming language R is used. Appropriate for biology, agriculture, nutrition, business, psychology, social science and other majors. 3 hours discussion. (005570)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 458 Sampling Methods **3 Units**
Prerequisite: MATH 314, MATH 315, or MATH 351 (may be taken concurrently).
Typically Offered: Spring only odd years
The theory and application of survey sampling techniques. Topics include simple random sampling, stratified sampling, systematic sampling, and cluster sampling. Appropriate for mathematics, computer science, psychology, social science, agriculture, biology, and other majors. 3 hours discussion. (005573)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 461 Numerical Analysis **3 Units**
Prerequisite: MATH 220 or MATH 260; completion of computer literacy requirement.
Typically Offered: Spring only
Approximation; numerical integration; numerical solution of ordinary and partial differential equations; interpolation and extrapolation. 3 hours discussion. (005584)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 465 Introduction to Complex Variables **3 Units**
Prerequisite: MATH 220.
Typically Offered: Fall only
Algebra of Complex Numbers, Cauchy-Riemann Equations, the exponential, trigonometric, and logarithmic functions, complex integration and Cauchy integral formula, Taylor and Laurent series, the residue theorem, conformal mapping, and applications. 3 hours discussion. (005577)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 472 Introduction to Chaotic Dynamical Systems **3 Units**
Prerequisite: MATH 260. Recommended: MATH 235, MATH 360.
Typically Offered: Fall only odd years
An introduction to the study of non-linear dynamical systems. Both discrete and continuous systems will be studied using classical analysis combined with geometric techniques and computer simulation. Areas of application include fractal geometry, coding theory, fluid turbulence, population fluctuation, and chaotic vibrations of structures and circuits. 3 hours discussion. (005588)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 475 Calculus of Variations **3 Units**
Prerequisite: MATH 260; MATH 361 is recommended.
Typically Offered: Fall only even years
Classical problems in the calculus of variations. Euler-Lagrange equations. Isoperimetric problems, Fermat's principle. Lagrangian and Hamiltonian mechanics of particles. Two independent variables. Applications to physics and engineering. 3 hours discussion. (005590)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 480 Mathematical Modeling **3 Units**
Prerequisite: MATH 235, MATH 260.
Typically Offered: Spring only
The translation of real world phenomena into mathematical language. Possible applications include population and competing species models, mathematical theories of war, traffic flow, river pollution, water waves and tidal dynamics, probabilistic and simulation models. 3 hours discussion. (005592)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

MATH 485 Advanced Topics in Data Science **3 Units**
Prerequisite: CSCI 385 or MATH 385; or admission to the MS in Data Science and Analytics.
Typically Offered: Spring only
This course focuses on critical concepts and practical tools in data science, preparing students to tackle complex, real-world problems. The course covers key areas such as linear algebra fundamentals for data science with applications to regression and dimension reduction. Students explore predictive modeling techniques, cross-validation, and model assessment while addressing the ethical implications of predictive analytics and data privacy. Through hands-on projects, students learn to collaborate effectively using modern version control tools, apply SQL for relational database queries, and practice communicating technical results to diverse audiences. Emphasis is placed on real-world applications, integrating theory with practical skills in data science workflows. 3 hours lecture. (021890)
Cross listing(s): CSCI 485
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Laptop required, see department for details.

MATH 490 Data Science Capstone **1-3 Units**
Prerequisite: MATH 485, senior standing, approved project, enrollment in the Data Science Certificate Program.
Typically Offered: Fall and spring
Students work independently to provide a service in the form of a data product to a local business, researcher, or community member. Students provide status reports at weekly meetings and present their finished project to a group of peers at the end of the semester in an appropriate venue such as at an undergraduate seminar series or poster symposium. 0 hours supervision. (021898)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Upper Division

MATH 495H Honors Reading Course **3 Units**
Prerequisite: Admission to the Department Honors Program, completion of MATH 420W with a grade of B or higher.
Typically Offered: Fall and spring
Directed reading in an advanced topic under the guidance of an Honors thesis supervisor. The course exceeds the usual level of difficulty associated with undergraduate work. It provides the background necessary to write an Honors thesis. 9 hours supervision. (005595)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Upper Division

MATH 498 Advanced Topics in Mathematics **1-3 Units**
Prerequisite: At least one 300- or 400-level mathematics course appropriate to the subject, faculty permission.
Typically Offered: Fall and spring
This course is for special topics offered for 1.0-3.0 units. Typically the topic is offered on a one-time-only basis and may vary from term to term and be different for different sections. See the Class Schedule for the specific topic being offered. 3 hours supervision. (005593)
Grade Basis: Graded
Repeatability: You may take this course more than once
Course Attributes: Upper Division

MATH 499 Special Problems **1-3 Units**
Prerequisite: Faculty permission.
Typically Offered: Fall and spring
This course is an independent study of special problems offered for 1.0-3.0 units. You must register directly with a supervising faculty member. 3 hours supervision. (005594)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Upper Division

MATH 499H Honors Thesis **3 Units**
Prerequisite: Completion of MATH 495H with a grade of B or higher, and approval by the department Honors advisor and thesis supervisor of the proposed thesis topic.
Typically Offered: Fall and spring
Preparation of written thesis in mathematics under supervision of Honors thesis advisor. The thesis, based on studies begun in MATH 495H, will require original work beyond that normally required in undergraduate work. Completed written thesis must be approved by the thesis supervisor and Honors advisor. A summary of the thesis will be presented by the student in public lecture. Successful completion of MATH 495H and MATH 499H is one of the requirements for being designated as an Honors graduate in mathematics. 9 hours supervision. (005596)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Upper Division

MATH 500 Data Science Seminar **1 Unit**
Typically Offered: Spring only
This seminar explores current and relevant applications and implementations of data science and analytical methods and tools in the field. Seminars include external and student-led presentations and hands-on tutorials. Emphasis is placed on students sharing and receiving feedback on an approved capstone or master's project. Appropriate for seniors and graduate students in relevant programs. 1 hour seminar. (022563)
Grade Basis: ABC/No Credit
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Upper Division; Laptop required, see department for details.

MATH 589 Field Experience in Statistics and Data Science **1-3 Units**
Prerequisite: one upper-division course in statistics, experience with R or Python, approved partnership agreement, and internship coordinator permission.
Typically Offered: Spring, summer, fall
This internship offers an authentic career experience emphasizing problem solving, decision-making, and collaboration skills, while gaining insights into leadership. Supervised by the internship coordinator and an organization representative on or off campus, students support daily operations of the partner organization. Each unit requires at least three hours per week of supervised professional development activities. 0 hours supervision. (022502)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 9 units
Course Attributes: Upper Division; Laptop required, see department for details.

MATH 608 Data Science for Graduate Studies **3 Units**
Prerequisite: Basic programming knowledge, admission to the master's in data science and analytics, or classified standing in the master's in computer science.
Typically Offered: Fall only
This course covers foundational practices of data science emphasizing reproducibility and ethical practices at all stages of the data science lifecycle. Recent advances and seminal works in data science and related fields will be discussed and scientific communication best practices will be addressed. Topics include version control, scientific thinking, web scraping, intermediate data wrangling, data visualization, modeling, prediction, classification, and text analysis in either R or Python. 3 hours discussion. (022535)
Cross listing(s): CSCI 608
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division; Laptop required, see department for details.

MATH 610 Topics in Mathematics for Secondary Teachers: Analysis **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore analysis topics appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of analysis. 3 hours seminar. (005599)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 615 Data Analysis for Graduate Research **3 Units**
Prerequisite: MATH 105, MATH 305, MATH 315, or MATH 350.
Typically Offered: Fall only
This course provides a hands-on introduction to using data to rigorously answer research questions. Students practice cleaning and manipulating data, creating data visualizations, and conducting introductory level statistical analysis using real-world data sets that are relevant to their field. Analysis topics include single and two-sample inference, analysis of variance, multiple regression, analysis of co-variance, experimental design, repeated measures, nonparametric procedures, and categorical data analysis. Reproducible research is strongly emphasized through the use of statistical computing software (e.g., SPSS, Stata, SAS, R, Python). Recommended for all majors that use data for research. 3 hours discussion. (005597)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

MATH 620 Topics in Mathematics for Secondary Teachers: Geometry **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore geometry appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of geometry. 3 hours seminar. (005602)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 621 Real Analysis **4 Units**
Prerequisite: CSCI 111, MATH 420W, and MATH 449 or equivalents.
Typically Offered: Fall and spring
In this graduate introductory analysis course topics include point set topology, measure theory, the Lebesgue integral, classical Banach spaces, and applications. 4 hours discussion. (022632)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Graduate Division

MATH 622 Applied and Computational Algebra **4 Units**
Prerequisite: CSCI 111, MATH 420W, and MATH 449 or equivalents.
Typically Offered: Fall and spring
Topics in this graduate course in applied and computational algebra include ring and field theory, polynomials and curves over finite fields, and applications to error-correcting codes. Python programming. 4 hours discussion. (022637)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Graduate Division

MATH 630 Topics in Mathematics for Secondary Teachers: Foundations of Mathematics **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore the foundations of mathematics topics appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of the foundations of mathematics. 3 hours seminar. (005601)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 633 Topics in Mathematics for Secondary Teachers: Number Theory **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore number theory appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of number theory. 3 hours seminar. (005605)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 635 Topics in Mathematics for Secondary Teachers: Discrete Mathematics **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore discrete mathematics topics appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of discrete mathematics. 3 hours seminar. (005600)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 637 Topics in Mathematics for Secondary Teachers: History of Mathematics **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore the history of mathematics appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of the history of mathematics. 3 hours seminar. (005603)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 640 Topics in Mathematics for Secondary Teachers: Modern Algebra **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore modern algebra topics appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of modern algebra. 3 hours seminar. (005598)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 641 Combinatorics and Graph Theory **4 Units**
Prerequisite: CSCI 111, MATH 420W, and MATH 449 or equivalents.
Typically Offered: Fall and spring
Topics in this graduate course in combinatorics and graph theory include graph algorithms, spanning trees, connectivity, Hamiltonian cycles, coloring, planarity, surface embeddings, and graph minors. Python programming. 4 hours discussion. (022638)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Graduate Division

MATH 642 Computational Number Theory **4 Units**
Prerequisite: MATH 317 or MATH 337 or equivalents.
Typically Offered: Fall and spring
Topics in this graduate course in computational number theory include prime numbers, representation by quadratic forms, pseudoprimes, primality proving, factorization algorithms, and elliptic curve arithmetic. Python programming. 4 hours discussion. (022639)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Graduate Division

MATH 643 Stochastic Processes **4 Units**
Prerequisite: MATH 350 or equivalent.
Typically Offered: Fall and spring
Topics in this graduate course in stochastic processes include Markov chains, Poisson processes, Brownian motion, and applications (e.g., Markov chain Monte Carlo). Python programming. 4 hours discussion. (022640)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Graduate Division

MATH 644 Partial Differential Equations **4 Units**
Prerequisite: MATH 260 or equivalent
Typically Offered: Fall and spring
First-order partial differential equations (PDEs) with two and multiple independent variables. Geometric aspects, characteristics strips, second-order parabolic, hyberbolic and elliptic equations, green functions and generalizations, integral transforms, non-linear PDEs, solitary waves, and applications. 4 hours discussion. (022641)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 4 units
Course Attributes: Graduate Division

MATH 650 Topics in Mathematics for Secondary Teachers: Probability and Statistics **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore probability and statistics appropriate for the secondary school curriculum. These topics and strategies provide a basis for reflective analysis and deepening knowledge of probability and statistics. 3 hours seminar. (005606)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 651 Probability and Statistics for Data Science **3 Units**
Prerequisite: MATH 121, MATH 615. Recommended: CSCI 485 or MATH 485.
Typically Offered: Spring only
This course covers simulation, probability theory and distributions, Bayes' methods, sampling distributions, and point and interval estimation. Also included are maximum likelihood, testing hypotheses, likelihood ratio tests, and multivariable regression theory. The statistical programming language R is used. 3 hours lecture. (022569)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division; Laptop required, see department for details.

MATH 660 Topics in Mathematics for Secondary Teachers: Mathematical Modeling **3 Units**
Prerequisite: Admission to the master's program in mathematics education or instructor permission.
Typically Offered: Inquire at department
Through an array of pedagogical strategies, secondary mathematics teachers explore mathematical modeling appropriate for the seconday school curriculum. These topics and strategies provide a basis for the reflective analysis and deepening knowledge of mathematical modeling. 3 hours seminar. (005604)
Grade Basis: Report in Progress: ABC/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 689 Internship in Statistics and Data Science II **1-3 Units**
Prerequisite: Math 589.
Typically Offered: Spring, summer, fall
This is a continuing internship experience where students continue to integrate theory and practice in a professional setting. Students are supervised by an agency representative and faculty coordinator but may work more independently. Each unit requires at least three hours per week of professional development activities. 0 hours supervision. (022811)
Grade Basis: Credit/No Credit
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division; Laptop required, see department for details.

MATH 690 Advanced Topics in Mathematics **4 Units**
Prerequisite: CSCI 111, MATH 420W, and MATH 449 or equivalents.
Typically Offered: Fall and spring
This course introduces advanced topics in modern mathematics. Topics may vary and include: numerical optimization, computational linear algebra, biomathematics, fractal geometry, lie groups, ergodic theory, homotopy theory, topological data analysis, and pedagogy of college-level mathematics. 4 hours discussion. (022642)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 12 units
Course Attributes: Graduate Division

MATH 696 Comprehensive Exam **3 Units**
Prerequisite: MATH 621, MATH 622 (may be taken concurrently). Classified status in the mathematics MS.
Typically Offered: Fall and spring
This course is for mathematics MS students who have chosen the comprehensive exam as their culminating activity. Students prepare for and take a customized comprehensive exam. 9 hours supervision. (022718)
Grade Basis: Report in Progress: CR/NC
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

MATH 697 Independent Study **1-3 Units**
Typically Offered: Fall and spring
This course is a graduate-level independent study offered for 1.0-3.0 units. You must register directly with a supervising faculty member. 3 hours supervision. (005616)
Grade Basis: Report in Progress: Graded
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 698 Grad Advanced Topics in Math **1-3 Units**
Typically Offered: Fall and spring
This course is for special topics offered for 1.0-3.0 units. Typically the topic is offered on a one-time-only basis and may vary from term to term and be different for different sections. See the Class Schedule for the specific topic being offered. 9 hours supervision. (005615)
Grade Basis: Graduate Graded
Repeatability: You may take this course more than once
Course Attributes: Graduate Division

MATH 699P Master's Project **1-3 Units**
Typically Offered: Fall and spring
This course is offered for 1.0-6.0 units. You must register directly with a supervising faculty member. 9 hours supervision. (005622)
Grade Basis: Report in Progress: CR/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division

MATH 699T Master's Thesis **1-3 Units**
Prerequisite: Classified status in the mathematics MS.
Typically Offered: Fall and spring
This course is for mathematics MS students who have chosen the thesis as their culminating activity. 9 hours supervision. (005620)
Grade Basis: Report in Progress: CR/NC
Repeatability: You may take this course for a maximum of 6 units
Course Attributes: Graduate Division