MATHEMATICS AND STATISTICS

College of Natural Sciences and Mathematics

Program Description

In today's highly technological society, the study of Mathematics takes on an increasingly important role. The Sacramento State Mathematics Department designs its courses with the goal of providing students with the mathematical concepts appropriate to the student's field.

The program consists of sequences of courses that lead to a Bachelor of Arts with a major in Mathematics, with emphasis in Pure Mathematics, Applied Mathematics, Statistics, or a Teacher Preparation Program. A minor in Mathematics or Statistics and a Master of Arts in Mathematics is also offered.

Degree Programs

Minor in Mathematics (https://catalog.csus.edu/colleges/natural-sciences-mathematics/mathematics-statistics/minor-in-mathematics/)

Minor is Statistics (https://catalog.csus.edu/colleges/natural-sciences-mathematics/mathematics-statistics/minor-in-statistics/)

BA in Mathematics (https://catalog.csus.edu/colleges/natural-sciences-mathematics/mathematics-statistics/ba-in-mathematics/)

BS in Statistics (https://catalog.csus.edu/colleges/natural-sciences-mathematics/mathematics-statistics/bs-in-statistics/)

MA in Mathematics (https://catalog.csus.edu/colleges/natural-sciences-mathematics/mathematics-statistics/ma-in-mathematics/)

Special Features

- The study of mathematics at Sacramento State has several strong advantages. The flexibility of the major gives students enough freedom to mold their degree along their particular interest.
- An excellent computer facility gives mathematics students easy access to the campus computer resources.
- Currently there is a demand for majors in mathematics with training in applied mathematics and statistics. Program graduates have had success in finding employment in public and private sectors.
- Since there is presently a need for high school mathematics teachers, some majors pursue a secondary teaching career. Graduate students in mathematics are finding opportunities for public and private employment in jobs requiring more advanced training in mathematics and statistics. Sacramento State Master's Degree graduates now teach at community colleges throughout the state. Upper division majors may check with the mathematics administrative support coordinator on the possibility of applying for paid positions as student assistants.
- Student assistants work from 10-20 hours per week in math-related duties on campus.

Note: Students interested in a major or minor in mathematics should contact the Department secretary for an advising appointment with a mathematics advisor.

Career Possibilities

Mathematics Teacher · Mathematician · Encryption Analyst · Quantitative Analyst · Engineering Analyst · Systems Analyst · Operations Analyst · Actuary · Risk Analyst · Image Scientist · Technical Writer · Statisticians involved in: Surveying/Polling, Biology/Agriculture, Business/Economics, Physical Sciences/Engineering

Contact Information

Kimberly Elce, Department Chair
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Department of Mathematics & Statistics (http://www.csus.edu/math/)

Faculty

BEHZADAN, ALI

CAPPIELLO, LAUREN

CETIN, COSKUN

CUMMINGS, JAY

DIAZ-ESCAMILLA, RAFAEL E.

ELCE, KIMBERLY

FITZGERALD, CLARK

GHOSH HAJRA, SAYONITA

HAMILTON, TRACY

HIGGINS, ABIGAIL

KANDEL, SANTOSH

KRAUEL, MATTHEW

LOUCKS-TAVITAS, JESSIE

LU, BIN

MARTINS, GABRIEL

PANNU, JASDEEP

PIGNO, VINCENT

RATTI, VARDAYANI

RICCIOTTI, DIEGO

SHANBROM, COREY

TAYLOR, LISA

TIMMONS, CRAIG

VANVALKENBURGH, MICHAEL

WISCONS, TOPAZ

WISCONS, JOSHUA

ZEIGLER, DAVID

ZHONG, JIANYUAN KATHY

MATH 1.   Mathematical Reasoning.   3 Units
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring, Summer

Recommended for students whose majors do not include a specific mathematics requirement. Objectives are to show some of the essence and quality of mathematics, and to enhance precision in the evaluation and expression of ideas, thereby developing a student's quantitative reasoning skills. Designed to give students an understanding of some of the vocabulary, methods, and reasoning of mathematics with a focus on ideas.

MATH 10.   Essentials of Algebra.   3 Units
Term Typically Offered: Fall, Spring, Summer

Prepares students for courses requiring fundamental algebra skills. Topics include: review of basic algebra; scientific notation, rounding, and percents; factoring; exponents; linear equations and inequalities with applications; quadratic equations with applications; graphing with applications; absolute value equations and inequalities; systems of linear equations and inequalities; and an introduction to exponential and logarithmic expressions.

MATH 12.   Algebra for STEM Courses.   4 Units
Term Typically Offered: Fall, Spring, Summer

Prepares students for Precalculus and other higher math courses requiring intermediate algebra. Topics include: linear equations and inequalities, absolute value equations and inequalities, systems of linear equations, quadratic equations, polynomial expressions and equations, rational expressions and equations, roots and radicals, and exponential & logarithmic properties and equations.
Note: Students who have received a C- or higher in a college level precalculus or calculus course are not eligible to enroll for credit without the permission of the instructor.

MATH 15H.   Honors Mathematical Reasoning.   3 Units
Prerequisite(s): Open only to Honors students.
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring

Introduction to the composition and interpretation of mathematical ideas and to the mathematical reasoning necessary to derive results in a variety of mathematical topics. Emphasis on developing concepts and analyzing results.

MATH 17.   An Introduction to Exploration, Conjecture, and Proof in Mathematics.   3 Units
Prerequisite(s): Score of 46 or higher on ALEKS PPL exam or MATH 10
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring

Prepares students for MATH 107A and MATH 107B. Students will explore mathematical patterns and relations, formulate conjectures, and prove their conjectures. Topics from number theory, probability and statistics, and geometry.

MATH 24.   Modern Business Mathematics.   3 Units
Prerequisite(s): Score of 51 or higher on ALEKS PPL exam or MATH 10
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring, Summer

Mathematics for business world, including functions, math of finance, linear programming and rates of change. Applications to economics and business will be emphasized throughout.

MATH 26A.   Calculus I for the Social and Life Sciences.   3 Units
Prerequisite(s): Score of 61 or higher on ALEKS PPL exam or MATH 12
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring, Summer

Limits, differentiation with applications, integration and applications in the Social Sciences and Life Sciences.

MATH 26B.   Calculus II for the Social and Life Sciences.   3 Units
Prerequisite(s): MATH 26A or appropriate high school based AP credit.
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring

Continuation of MATH 26A, integration and applications to the Social Sciences and Life Sciences. Multi-variate analysis including partial differentiation and maximization subject to constraints; elementary differential equations; sequences and series. Calculus of the trigonometric functions as time allows.
Note: Not open to students already having credit for MATH 31 or equivalent.

MATH 29.   Pre-Calculus Mathematics.   4 Units
Prerequisite(s): Score of 61 or higher on ALEKS PPL exam or MATH 12
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring, Summer

Designed to prepare students for calculus. Topics: trigonometry, points and lines in the Cartesian plane; lines and planes in space; transformation of coordinates; the conics; graphs of algebraic relations; the elementary transcendental functions.

MATH 29A.   Pre-Calculus Mathematics A.   2 Units
Prerequisite(s): MATH 12
Term Typically Offered: Fall, Spring, Summer

First semester of a two semester course that is designed to prepare students for calculus. Topics: functions and graphs, polynomial functions, rational functions and applications. Lecture two hours.

MATH 29B.   Pre-Calculus Mathematics B.   2 Units
Prerequisite(s): MATH 29A.
Corequisite(s): MATH 29M.
Term Typically Offered: Fall, Spring, Summer

Second semester of a two semester course that is designed to prepare students for calculus. Topics: exponential and logarithmic functions, trigonometric functions, analytic geometry, and applications. Lecture two hours.

MATH 29L.   Lab for Pre-Calculus Math A.   **1 Unit**
Corequisite(s): MATH 29B.
Term Typically Offered: Fall, Spring

Workshop designed to deepen the understanding of pre-calculus developed in MATH 29A.
Note: May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree.
Laboratory

MATH 29M.   Lab for Pre-Calculus Math B.   **1 Unit**
Corequisite(s): MATH 29B.
Term Typically Offered: Fall, Spring

Workshop designed to deepen the understanding of pre-calculus developed in MATH 29B.
Note: May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree.
Laboratory

MATH 30.   Calculus I.   **4 Units**
Prerequisite(s): Score of 76 or higher on ALEKS PPL exam or MATH 29 or MATH 29B
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring, Summer

Functions and their graphs; limits; the derivative and some of its applications; trigonometric and hyperbolic functions and their inverses; the integral; the fundamental theorem; some applications of the integral.

MATH 30L.   Laboratory for First Semester Calculus.   **1 Unit**
Corequisite(s): Enrollment in a designated section of MATH 30.
Term Typically Offered: Fall, Spring

Workshop designed to deepen the understanding of calculus developed in MATH 30.
Note: May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree.
Laboratory

Credit/No Credit

MATH 31.   Calculus II.   **4 Units**
Prerequisite(s): MATH 30 or appropriate high school based AP credit.
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring, Summer

MATH 30 continuation. Methods of integration; improper integrals; analytic geometry; infinite sequences and series.

MATH 31L.   Laboratory for Second Semester Calculus.   **1 Unit**
Corequisite(s): Enrollment in a designated section of MATH 31.
Term Typically Offered: Fall, Spring, Summer

Workshop designed to deepen the understanding of calculus developed in MATH 31.
Note: May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree.
Laboratory

Credit/No Credit

MATH 32.   Calculus III.   **4 Units**
Prerequisite(s): MATH 31.
Term Typically Offered: Fall, Spring, Summer

Continuation of Calculus II. Algebra and calculus of vectors; functions of several variables; partial differentiation; multiple integration; vector analysis.

MATH 35.   Introduction to Linear Algebra.   **3 Units**
Prerequisite(s): MATH 31.
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring

Careful development of matrices, systems of equations, determinants, vector spaces, linear transformations, orthogonality, real and complex eigenvalues; R3 viewed as a vector space with generalization to Rn.

MATH 45.   Differential Equations for Science and Engineering.   **3 Units**
Prerequisite(s): MATH 31.
Term Typically Offered: Fall, Spring, Summer

First order differential equations, second order differential equations with constant coefficients. Laplace transforms, small systems of linear differential equations, numerical methods, introduction to second order differential equations with variable coefficients.

MATH 64.   Mathematical Programming.   **3 Units**
Prerequisite(s): MATH 30 or a score of 4 or higher on the AP Calculus AB exam or instructor approval.
Term Typically Offered: Fall, Spring

Computational strategies in mathematical problem solving; implementation of mathematical algorithms; programming concepts including variables, functions, data structures, and control flow; data visualization, typesetting, and report generation.

MATH 96C.   Academic Strategies for Math 10 - NSM:Mathematics and Statistics.   **1 Unit**
Corequisite(s): Math 10
Term Typically Offered: Fall, Spring, Summer

Supplemental instruction for Math 10 focused on developing study skills and effective learning strategies.
Credit/No Credit

MATH 96D.   Academic Strategies for Math 24 - NSM:Mathematics and Statistics.   **1 Unit**
Corequisite(s): MATH 24
Term Typically Offered: Fall, Spring, Summer

Supplemental instruction for Math 24 focused on developing study skills and effective learning strategies.
Credit/No Credit

MATH 96E.   Elem Math Content Adv Viewpoin.   1 Unit
Corequisite(s): MATH 96G
Term Typically Offered: Fall, Spring, Summer

MATH96E is a 1-unit, 1-week early start course for baccalaureate credit
designed to prepare students for fall GE area B4. Working independently
and collaboratively, students will use an inquiry-based approach to
learning through research, reflection, and engagement with real world
scenarios. Students will develop various academic literacies in order
to understand the conventions of quantitative reasoning required for
success in a college setting.
Cross listed: ENGL 96A

Credit/No Credit

MATH 96F.   Mathematical Programming.   3 Units
Prerequisite(s): MATH 30 or appropriate high school based AP credit
Term Typically Offered: Fall, Spring

Computational strategies in mathematical problem solving;
implementation of mathematical algorithms; programming concepts
including variables, control flow, data structures, and functions; data
visualization, typesetting, and report generation.

MATH 96G.   Skills for Success in Mathematics.   1 Unit
Corequisite(s): MATH 96E
Term Typically Offered: Summer only

A 1-week Smart Start course for baccalaureate credit designed to
prepare students for the GE Area B4 pipeline. Working independently
and collaboratively, students will develop quantitative reasoning skills
necessary for successful completion of mathematics and statistics
courses in a college setting.
Credit/No Credit

MATH 99.   Special Problems.   1 - 6 Units
Term Typically Offered: Fall, Spring

Individual projects or directed reading. Permits a student to pursue
study and research in an area not otherwise available through the regular
curriculum.
Note: Open only to students who appear competent to carry on individual
work; admission requires the approval of the faculty member under whom
individual work is to be conducted, and approval of the advisor and the
Department Chair.

Credit/No Credit

MATH 100.   Applied Linear Algebra.   3 Units
Prerequisite(s): MATH 26B or MATH 31.
Term Typically Offered: Fall, Spring

Linear algebra and its elementary applications. Topics: Matrix algebra;
simultaneous linear equations; linear dependence and vector spaces;
rank and inverses; determinants; numerical solution of simultaneous
linear equations; linear transformations; eigenvalues and eigenvectors;
unitary and similarity transformations; quadratic forms.
Note: May not be taken for credit toward a mathematics major.

MATH 101.   Combinatorics.   3 Units
Prerequisite(s): MATH 31
Term Typically Offered: Spring only

Introduction to the art of counting. The focus will be on actually listing
the objects being counted in small cases and using the knowledge
gained in working with small cases to build toward general principles.
Sum and product principles, models of counting, permutations and
combinations, equivalence relations and partitions, inclusion-exclusion
principle, recurrence relations, and generating functions.

MATH 102.   Number Theory.   3 Units
Prerequisite(s): MATH 31.
Term Typically Offered: Fall, Spring

Theory of divisibility; some number theoretical functions; congruencies
(linear and quadratic); some Diophantine equations. Simple continued
fractions.

MATH 104.   Vector Analysis.   3 Units
Prerequisite(s): MATH 32.
Term Typically Offered: Spring only

Vector and scalar fields, integral theorems, orthogonal curvilinear
coordinates, vector spaces and linear transformations, applications to
physical fields and operators.

MATH 105A.   Advanced Mathematics for Science and Engineering I.
4 Units
Prerequisite(s): MATH 32, MATH 45.
Term Typically Offered: Fall only

Survey of second order linear differential equations, power series and
Fourier series solutions, solution of partial differential equations by
separation of variables.

MATH 105B.   Advanced Mathematics for Science and Engineering II.
4 Units
Prerequisite(s): MATH 105A.
Term Typically Offered: Spring only

Partial differential equations continued, complex function theory and its
applications.

MATH 107A.   Fundamental Mathematical Concepts.   3 Units
Prerequisite(s): MATH 17.
Term Typically Offered: Fall, Spring

First half of a one-year course in the structure of the real number
system and its sub-systems and in the basic properties and concepts of
geometry. Topics will include: definitions and properties of set theory and
their use in the development of the natural and whole number systems,
definitions and properties of the arithmetic relations and operations for
the natural numbers, whole numbers, integers.
Note: May not be taken for credit toward a mathematics major or minor.

MATH 107B.   Fundamental Mathematical Concepts.   3 Units
Prerequisite(s): MATH 107A.
Term Typically Offered: Fall, Spring

Continuation of MATH 107A. Topics will include: rational numbers, real
numbers, measurement, Euclidean Geometry.
Note: May not be taken for credit toward a mathematics major or minor.

MATH 107C.   Elementary Mathematics and the Learning Process.
3 Units
Prerequisite(s): MATH 17, MATH 107A or MATH 107B, and CHDV 30 or CHDV 35.
Term Typically Offered: Fall, Spring

Students will build on their understanding of material of Math 17, Math 107A/B by deepening their understanding of the concepts taught in these courses. This will be done by examining these concepts in relationship to theories of learning and development. Students will examine mathematical concepts related to K-8 with respect to the treatment of reasoning, communication, and the perspective of cognitive and social constructivism; and throughout the course will consider the question of "What is mathematics?" and "How is mathematics learned?

MATH 108.   Introduction to Formal Mathematics.   3 Units
Prerequisite(s): MATH 31, MATH 35.
Term Typically Offered: Fall, Spring

Logic of mathematical proof, set theory, relations, functions. Examples and applications from set cardinality, algebra, and analysis.

MATH 110A.   Modern Algebra.   3 Units
Prerequisite(s): MATH 108.
Term Typically Offered: Fall, Spring

First half of a one-year introductory course in algebraic concepts. Topics include: groups, subgroups, properties of groups, permutation groups, factor groups, homomorphism theorems.

MATH 110B.   Modern Algebra.   3 Units
Prerequisite(s): MATH 110A.
Term Typically Offered: Fall, Spring

Continuation of MATH 110A.
Note: Topics include

MATH 117.   Linear Algebra.   3 Units
Prerequisite(s): MATH 110A.
Term Typically Offered: Fall, Spring

Abstract linear spaces and linear transformations; invariant subspaces; canonical forms.

MATH 121.   College Geometry.   3 Units
Prerequisite(s): MATH 31; MATH 32 or MATH 35.
Term Typically Offered: Fall, Spring

Study of the axioms and theorems of Euclidean geometry. A comparison of several geometry axiom systems and their theorems, including those of some non-Euclidean and finite geometries.

MATH 130A.   Functions of a Real Variable.   3 Units
Prerequisite(s): MATH 32 and MATH 108.
Term Typically Offered: Fall, Spring

First half of a one-year upper division course in functions of a real variable. The first semester will consist of a rigorous development of the theory of real-valued sequences and continuity and differentiation for functions of one real variable.

MATH 130B.   Functions of a Real Variable.   3 Units
Prerequisite(s): MATH 130A.
Term Typically Offered: Fall, Spring

Continuation of MATH 130A. This semester will be devoted to a rigorous development of the theory of Riemann integration, infinite series, and sequences and series of functions.

MATH 134.   Functions of a Complex Variable and Applications.   3 Units
Prerequisite(s): MATH 32.
Term Typically Offered: Spring only

Complex plane; analytic functions; integration and Cauchy's Theorem; sequences and series; residue calculus; applications to potential theory; Fourier and Laplace transforms.

MATH 150.   Introduction to Numerical Analysis.   3 Units
Prerequisite(s): MATH 31
Term Typically Offered: Spring only

Numerical solutions of algebraic and transcendental equations; interpolation, inverse interpolation, finite differences, cubic splines, and applications; numerical differentiation and integration; direct and iterative numerical solutions of linear systems; discrete and continuous least squares approximation.

MATH 161.   Mathematical Logic.   3 Units
Prerequisite(s): MATH 108.
Term Typically Offered: Fall, Spring

Advanced study of logic with special application to mathematics.

MATH 162.   Set Theory.   3 Units
Prerequisite(s): MATH 108.
Term Typically Offered: Fall only

Axiomatic study of set theory. Topics usually considered include: relations and functions; set theoretical equivalence; finite and infinite sets; cardinal arithmetic; ordinal numbers and transfinite induction; variants of the Axiom of Choice.

MATH 170.   Linear Programming.   3 Units
Prerequisite(s): MATH 31; MATH 35 or MATH 100.
Term Typically Offered: Fall only

Theory of linear programming, duality, simplex method, integer programming, applications.

MATH 190.   History Of Mathematics.   3 Units
Prerequisite(s): MATH 31 and upper division status in mathematics.
Term Typically Offered: Fall, Spring

Study of the development of mathematical ideas and techniques and their impact on the general course of the history of western civilization.

MATH 193.   Capstone Course for the Teaching Credential Candidate.
3 Units
Prerequisite(s): Successful completion of at least five of the following: MATH 102, MATH 110A, MATH 110B, MATH 121, MATH 130A, MATH 130B or MATH 190; MATH 110A or MATH 130A may be taken concurrently.
Term Typically Offered: Fall, Spring

Reviews the major themes presented in the upper division program in Mathematics, and relates the themes to junior high school and high school curriculum. Required for all subject matter students.
Note: Not accepted for credit for non-Teaching Credential students.

MATH 196K.   Introduction to Differential Geometry.   3 Units
Prerequisite(s): MATH 32, and MATH 35 or instructor's permission
Term Typically Offered: Spring only

Calculus methods are applied to the study of curves and surfaces in three dimensional space. After an introduction to the geometry of curves (curvature, torsion, and Frenet's formulas), the course explores the geometry of surfaces. Some of the geometrical properties of a surface that will be investigated are its first and second fundamental forms, its various curvatures (normal, principal, mean, and Gaussian curvatures), and its geodesic curves.

MATH 198.   Seminar for Mathematics Tutors.   2 Units
Prerequisite(s): Students must be working as tutors in a campus-based program.
Term Typically Offered: Fall, Spring

Supports Sacramento State students who are working in tutorial and related roles in mathematics programs on campus. Focus on questioning as a fundamental strategy for teaching mathematics, on classroom observation, and on communication among mathematics instructors in support of effective teaching and learning.
Note: May be repeated up to two times for credit.

Credit/No Credit

MATH 199.   Special Problems.   1 - 6 Units
Term Typically Offered: Fall, Spring

Individual projects or directed reading. Open only to those students who appear competent to carry on individual work. Admission to this course requires the approval of the faculty member under whom the individual work is to be conducted, in addition to the approval of the advisor and the Department Chair.
Credit/No Credit

MATH 202.   Theory of Numbers.   3 Units
Prerequisite(s): Math 110A or equivalent; Math 110B is recommended.
Term Typically Offered: Fall, Spring

Divisibility properties of the integers, primes, modular arithmetic, Chinese Remainder Theorem, quadratic reciprocity and quadratic forms, arithmetic functions, the Möbius inversion formula, and Diophantine equations. Possible additional topics include elliptic curves, algebraic numbers, primes in arithmetic progressions, the geometry of numbers, p-adic numbers, primality tests, modular forms, and encryption.

MATH 210A.   Algebraic Structures. ✏   3 Units
Prerequisite(s): MATH 110B.
Term Typically Offered: Fall only

Graduate level course in algebraic structures. Topics include group theory including permutation groups, subgroups, homomorphisms, quotient groups, group actions, Sylow theorems and the theory of finite Abelian groups, as well as an introduction to ring theory including ideals, quotient rings, and integral domains.

MATH 210B.   Algebraic Structures.   3 Units
Prerequisite(s): MATH 210A.
Term Typically Offered: Fall, Spring

Fields; vector spaces; Galois theory.

MATH 220.   Topology.   3 Units
Prerequisite(s): MATH 130B.
Term Typically Offered: Fall, Spring

Topological spaces, open and closed sets, convergence and continuity; basis of a topology, subspace topology, product topology and metric topology; limit points, interior points, closure of a subset and boundary of a subset; connectedness, generalized intermediate value theorem, compactness, generalized extreme value theorem and applications.

MATH 220A.   Topology.   3 Units
Prerequisite(s): MATH 130B.
Term Typically Offered: Fall, Spring

Point set topology, continuity, compactness, connectedness.

MATH 230A.   Real Analysis.   3 Units
Prerequisite(s): MATH 130B.
Term Typically Offered: Fall, Spring

Metric topology; the theory of the derivative; measure theory.

MATH 230B.   Real Analysis.   3 Units
Prerequisite(s): MATH 230A.
Term Typically Offered: Fall, Spring

Continuation of MATH 230A, with topics selected from: Theory of the integral, including Riemann, Riemann Stieltjes, and Lebesque integrals.
Note: May be taken twice with approval of the graduate coordinator.

MATH 234.   Complex Analysis.   3 Units
Prerequisite(s): Math 130B and Math 32, or instructor permission.
Term Typically Offered: Fall, Spring

Complex numbers, including roots and powers. Complex functions, including branch cuts, and multivariable, exponential, logarithmic, analytic, and harmonic functions. Complex differentiation and integration, including line integrals and Cauchy¿s Theorem. Series, including power series, analytic functions, meromorphic functions, and calculus of residues.

MATH 234A.   Complex Analysis.   3 Units
Prerequisite(s): MATH 130B; MATH 105B or MATH 134 is recommended.
Term Typically Offered: Fall, Spring

Complex numbers, complex functions, analytic functions, complex integration, harmonic functions.

MATH 241.   Applied Functional Analysis.   3 Units
Prerequisite(s): Math 130B and either Math 100 or Math 35, or instructor permission.
Term Typically Offered: Fall, Spring

Normed spaces, Banach spaces; inner product spaces, Hilbert spaces; linear operators on Banach spaces; Hahn-Banach theorem, uniform boundedness principle, closed graph theorem; linear operators on Hilbert spaces.

MATH 248.   Lie Theory.   3 Units
Prerequisite(s): Math 110A and Math 130A, or consent of instructor.
Term Typically Offered: Fall, Spring

Introduction to Lie algebras, Lie groups, and their connection. Emphasis is placed on examples given by matrices. Representation theory of Lie algebras or groups. Additional topics may include: applications to physics, the Baker-Campbell-Hausdorff Formula, one-parameter subgroups, root systems, the structure and classification of simple Lie algebras, and the topology of Lie groups.

MATH 296B.   Theory of Numbers.   **3 Units**
Prerequisite(s): Math 110A or equivalent.
Term Typically Offered: Fall, Spring

This class will cover divisibility properties of the integers, primes and primality tests, modular arithmetic, Chinese Remainder Theorem, quadratic reciprocity and quadratic forms, arithmetic functions, the Mobius inversion formula, and Diophantine equations. Possible additional topics include elliptic curves, algebraic numbers, primes in arithmetic progressions, the geometry of numbers and encryption.

MATH 296C.   Lie Theory.   **3 Units**
Prerequisite(s): Math 110A and Math 130A, or consent of instructor.
Term Typically Offered: Fall, Spring

The course gives a basic introduction to Lie algebras and their connections to Lie groups. Emphasis will be on examples given by matrices. Beyond an introduction to Lie algebras and groups, possible specific topics are: the classification and construction of simple Lie algebras; ADE classification; universal enveloping algebras; semi-simple Lie algebras and their representation theory; Lie group representations; subgroups and subalgebras; one-parameter subgroups; and the exponential map.

MATH 299.   Special Problems.   **1 - 6 Units**
Term Typically Offered: Fall, Spring

Any properly qualified student who wishes to pursue a problem may do so if the proposed subject is acceptable to the supervising instructor and to the student's advisor.
Credit/No Credit

MATH 316.   The Psychology of Mathematics Instruction.   **2 Units**
Prerequisite(s): Admission to the Mathematics Blended Program.
Term Typically Offered: Fall only

A survey course for students in the Blended Program in Mathematics that relates broad areas of educational psychology and theories of learning to instruction in the secondary mathematics classroom. The focus is on practical applications of theories through the design of lesson and unit plans. Students will design learning activities for diverse classes of learners, including English Language Learners, and build and refine assessment plans that include formative assessments. Lecture two hours.

MATH 371A.   Schools and Community A.   **2 Units**
Corequisite(s): Enrollment in EDTE 470A.
Term Typically Offered: Fall, Spring

The first of a two-part sequence supporting student teachers in the Mathematics Blended Program. Focus is on strategies for secondary mathematics instruction, the process of reflection on teaching, communication among mathematics teachers in support of effective teaching and learning, strategies for engagement, questioning, creating a safe classroom environment, classroom management, assessment, and familiarity with school and community resources. Emphasis on issues related to English Language Learners, special needs students, and intervention strategies. Seminar two hours.
Credit/No Credit

MATH 371B.   Schools and Community B.   **2 Units**
Corequisite(s): Enrollment in EDTE 470B.
Term Typically Offered: Fall, Spring

The second of a two-part sequence supporting student teachers in the Mathematics Blended Program. Focus is on strategies for secondary mathematics instruction, the process of reflection on teaching, communication among mathematics teachers in support of effective teaching and learning, strategies for engagement, questioning, creating a safe classroom environment, classroom management, assessment, and familiarity with school and community resources. Emphasis on issues related to English Language Learners, special needs students, and intervention strategies. Seminar two hours.
Credit/No Credit

MATH 500.   Culminating Experience.   **1 - 3 Units**
Prerequisite(s): Advanced to candidacy and permission of the graduate coordinator.
Term Typically Offered: Fall, Spring

Directed reading programs for master's candidates preparing for written comprehensive examinations.

STAT 1.   Introduction to Statistics.   **3 Units**
Prerequisite(s): Math 10 or a score of 51 or higher on a proctored ALEKS PPL exam.
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring

Descriptive statistics, basic concepts of probability and sampling with the aim of introducing fundamental notions and techniques of statistical inference.

STAT 10A.   Introductory Statistics with Developmental Mathematics.
                                                                         3 Units
Term Typically Offered: Fall, Spring, Summer

Prepares students for STAT 10B that requires background in data analysis process, descriptive statistics and the concept of randomness. Topics include: Summarizing the data distribution graphically and numerically; reasoning about bivariate numerical data; linear correlation and regression; linear, quadratic and exponential functions as a way of modeling a correspondence between two variables; reasoning about bivariate categorical data; basic concepts of probability and the law of large numbers; conditional probability; discrete random variables; binomial distribution; and an introduction to continuous random variables. Lecture three hours.

STAT 10B.   Introductory Statistics with Developmental Mathematics.
                                                                         3 Units
Prerequisite(s): STAT 10A
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Spring only

Continuation of STAT 10A. Stat 10B prepares students for research methods applications/ courses in various disciplines. Topics include: Continuous random variables and normal distribution; sampling distributions and the central limit theorem; confidence intervals and tests of hypotheses for means, proportions, difference in means and difference in proportions; and chi-squared tests for categorical data analysis. Lecture three hours.

STAT 50.   Introduction to Probability and Statistics.   4 Units
Prerequisite(s): MATH 26A, MATH 30, or appropriate high school based AP credit.
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall, Spring, Summer

Sample spaces, combinatorics, and random variables. Density and distribution functions. Expectation, variance, and covariance. The binomial, uniform, poisson, negative binomial, hypergeometric, exponential, gamma, beta, and normal distributions. Sampling distributions, estimation, and hypothesis tests. Students are given periodic writing assignments which encourage them to think through concepts of the course.

STAT 96.   Experimental Offerings in Statistics.   1 - 6 Units
Term Typically Offered: Fall, Spring

When there is a demand from a sufficient number of qualified students, one of the staff will conduct a seminar on some topic in statistics.

STAT 103.   Intermediate Statistics.   3 Units
Prerequisite(s): STAT 50 or instructor consent
Term Typically Offered: Spring only – even years

Review of hypothesis testing --one sample. Hypothesis testing --two sample, variance. Regression and correlation. Analysis of variance including two-way. Analysis of categorical data. Non-parametric tests, goodness of fit, and tests for randomness.

STAT 115A.   Introduction to Probability Theory.   3 Units
Prerequisite(s): MATH 31 and either STAT 1 or STAT 50
Term Typically Offered: Fall only

Probability axioms, discrete and continuous random variables, functions of random variables, joint densities, expectation, moment generating functions. Chebyshev's inequality, transformations, weak law of large numbers, central limit theorem.

STAT 115B.   Introduction to Mathematical Statistics.   3 Units
Prerequisite(s): STAT 115A.
Term Typically Offered: Spring only

Point Estimation, interval estimation, hypothesis testing, the multivariate normal distribution, non-parametric tests.

STAT 128.   Statistical Computing.   3 Units
Prerequisite(s): (STAT 1 or STAT 50) and (MATH 26A or MATH 30) or consent of the instructor.
Computer methods for accessing, transforming, summarizing, graphing and making statistical inferences from data; focus is on command-line statistical software, but menu-driven software may be introduced; application of computer methods to solve problems selected from the areas of modeling, simulation, inference and statistical learning.

STAT 129.   Analyzing and Processing Big Data.   3 Units
Prerequisite(s): (STAT 1 or STAT 50) and (MATH 26A or MATH 30) and (STAT 128 or CSC 20), or consent of the instructor.
Term Typically Offered: Fall, Spring

Statistical analysis of large, complex data sets. Topics include memory efficient data processing, the split-apply-combine strategy, rewriting programs for scalability, handling complex data formats, and applications such as statistical learning, dimension reduction, and efficient data representation. Students will access data and run code on remote servers.

STAT 140A.   Linear Models.   3 Units
Prerequisite(s): Stat 115A and Stat 128 and (Math 35 or Math 100)
Term Typically Offered: Fall only

Practical statistical modeling of data using professional-grade statistical software. Simple and multiple linear regression, analysis of variance, logistic regression, variable transformation, variable selection, model selection, residual analysis.

STAT 140B.   Statistical Learning.   3 Units
Prerequisite(s): Stat 140A
Term Typically Offered: Spring only

Practical statistical modeling of data using professional-grade software. Principles, methodologies, and applications of supervised techniques such as classification, resampling, model selection, nonlinear regression, and tree-based methods. Unsupervised techniques including clustering and dimension reduction.

STAT 141.   Introduction to Data Science.   3 Units
Prerequisite(s): One of (Stat 1, Stat 10B, Stat 50, Psyc 9, Soc 101, Swrk 110, Engr 115). Other courses may be accepted based on instructor discretion.
General Education Area/Graduation Requirement: MathematicalConcepts & QuantitativeReasoning (2-A)
Term Typically Offered: Fall only

Exploratory data analysis, data visualization, summarization, inference, modeling, and effective communication of results. Focus on professional data science software, real world data sets, and relevant questions.

STAT 155.   Introduction to Techniques of Operations Research.   3 Units
Prerequisite(s): MATH 31; STAT 50, STAT 103, or STAT 115A; MATH 31 may be taken concurrently.
Term Typically Offered: Spring only – odd years

Formulation and analysis of mathematical models with emphasis on real systems applications. Introduction to Queueing theory and Markov Processes for application.

STAT 191.   Community Service Learning in Statistics.   1 Unit
Prerequisite(s): Stat 128 Service Learning may be required.
Term Typically Offered: Fall, Spring

15-20 hours of volunteer work in the community related to statistics. Students will choose a project and submit a proposal for instructor review and approval. Students are encouraged to seek out opportunities that will benefit the community.
Credit/No Credit

STAT 192.   Statistics Capstone Project.   3 Units
Prerequisite(s): Stat 128, Stat 115A, Stat 140A, Stat 191 Service Learning may be required.
Term Typically Offered: Spring only

Capstone course for statistics majors. Students work in small groups on a project that brings together skills developed across multiple upper division statistics courses. In a typical project, students will define a complex problem, create a data analysis plan, learn and apply new methodologies, communicate with clients, write statistical reports, and present results to an audience.
Note: Stat 115B is a recommended prerequisite.

STAT 196J.   Statistical Computing.   3 Units
Prerequisite(s): STAT 1 or STAT 50, and MATH 26A or MATH 30
Term Typically Offered: Fall only

Computer methods for accessing, transforming, summarizing, graphing, and making statistical inferences from data. Both a command-line statistical software package such as R and menu-driven package such as SAS will be used. Students will learn to apply computer methods to solve problems selected from the areas of modeling, simulation, inference and statistical learning. The intent of this course is to provide students with the software skills needed for statistical work in industry or academia.

STAT 196L.   Linear Models.   3 Units
Prerequisite(s): (Stat 1 or Stat 50) and (Math 35 or Math 100); an introductory programming course such as Math 64 or Stat 128 is recommended.
Term Typically Offered: Fall, Spring

Practical statistical modeling of data using professional-grade statistical software. Simple and multiple linear regression; analysis of variance; logistic regression; variable transformation; variable selection; model selection; residual analysis.

STAT 196M.   Introduction to Statistical Learning.   3 Units
Prerequisite(s): (Stat 1 or Stat 50) and (Math 35 or Math 100); Math 64, Stat 128, or a similar introductory programming course is recommended. Stat 196L or a similar introductory linear regression course recommended.
Term Typically Offered: Fall, Spring

Practical statistical modeling of data using professional-grade software. Principles, methodologies, and applications of supervised techniques such as classification, resampling, model selection, nonlinear regression, and tree-based methods; unsupervised techniques including clustering and dimension reduction.

STAT 199.   Special Problems.   1 - 6 Units
Term Typically Offered: Fall, Spring

Individual projects or directed reading. Open only to students who appear competent to carry on individual work. Admission to this course requires approval of the instructor in addition to the approval of the advisor and the Department Chair.
Credit/No Credit

STAT 215A.   Introduction to Mathematical Statistics.   3 Units
Prerequisite(s): STAT 115A, STAT 115B; MATH 134 is recommended.
Term Typically Offered: Fall, Spring

Probability measure, conditional probability and independence, random variables, characteristic and moment-generating functions, modes of convergence.

STAT 299.   Special Problems.   1 - 6 Units
Term Typically Offered: Fall, Spring

Any properly qualified student who wishes to pursue a problem may do so if the proposed subject is acceptable to the department committee, the supervising instructor and the student's advisor.