Mathematical and Computer Sciences

In the College of Sciences

OFFICE: Business Administration/Mathematics 203
TELEPHONE: (619) 594-6191

Faculty

Mathematics and Applications

John D. Elwin, Ph.D., Professor of Mathematical and Computer Sciences, Chair of Department

David H. Carlson, Ph.D., Professor of Mathematical and Computer Sciences

José Castillo, Ph.D., Professor of Mathematical and Computer Sciences (M.S. Computational Science Graduate Adviser)

T. Marc Dunster, Ph.D., Professor of Mathematical and Computer Sciences

Tunc Geveci, Ph.D., Professor of Mathematical and Computer Sciences

Robert D. Grone, Ph.D., Professor of Mathematical and Computer Sciences (Coordinator and M.A. Mathematics Graduate Adviser)

Stefen Hui, Ph.D., Professor of Mathematical and Computer Sciences (M.S. Applied Mathematics with Concentration in Mathematical Theory of Communication Systems Graduate Adviser)

Frank D. Lesley, Ph.D., Professor of Mathematical and Computer Sciences

Donald A. Lutz, Ph.D., Professor of Mathematical and Computer Sciences

Joseph M. Mahaffy, Ph.D., Professor of Mathematical and Computer Sciences

Stephen J. Pierce, Ph.D., Professor of Mathematical and Computer Sciences

Peter Salamon, Ph.D., Professor of Mathematical and Computer Sciences (M.S. Applied Mathematics Graduate Adviser)

Stephen J. Kirschvink, Ph.D., Associate Professor of Mathematical and Computer Sciences

Michael O'Sullivan, Ph.D., Assistant Professor of Mathematical and Computer Sciences

Antonio Palacios, Ph.D., Assistant Professor of Mathematical and Computer Sciences

Mathematics Education

Nicholas A. Branca, Ed.D., Professor of Mathematical and Computer Sciences

G. Brian Greer, Ph.D., Professor of Mathematical and Computer Sciences

Douglas B. McLeod, Ph.D., Professor of Mathematical and Computer Sciences

Larry K. Sowder, Ph.D., Professor of Mathematical and Computer Sciences (Coordinator and M.A.T.S. Graduate Adviser)

Janet Sue Bowers, Ph.D., Assistant Professor of Mathematical and Computer Sciences

Jennifer Chauvot, Ph.D., Assistant Professor of Mathematical and Computer Sciences

Joanne Lobato, Ph.D., Assistant Professor of Mathematical and Computer Sciences

Associateships

Graduate teaching associateships in mathematics are available to a limited number of qualified students. Application blanks and additional information may be secured from the chair of the department.

General Information

The Department of Mathematical and Computer Sciences offers graduate study leading to the Master of Arts degree in mathematics, the Master of Arts degree for teaching service with a concentration in mathematics, the Master of Science degree in applied mathematics, the Master of Science degree in statistics (see the Statistics section of this bulletin for a description of the statistics program and courses), and the Master of Science degree in computer science. (See the Computer Science section of this bulletin for a description of the computer science program.)

Faculty active in research direct theses and research projects in most general areas of the mathematical sciences: in complex analysis, differential equations, graph theory, group theory, matrix theory, number theory, numerical analysis, operator theory; in cognitive science, computer education and problem solving within mathematics education; in control theory, mathematical physics, modeling and optimization, financial mathematics, mathematics of communication, and computational mathematics within applied mathematics; in biostatistics, data analysis, inference, stochastic processes, survival analysis and time series within statistics; in algorithms, computability, formal language, numerical analysis, and system software (artificial intelligence, database management, distributed processing, graphics and operating systems) within computer science.

Opportunities for research in mathematics education are available through research facilities in the Center for Research in Mathematics and Science Education. Research facilities of the department include the Robotics and Intelligent Machines Laboratory which provides opportunities for research in computer science (see Computer Science section).

Admission to Graduate Study

All students must satisfy the general requirements for admission to the University with classified graduate standing, as described in Part Two of this bulletin.

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy as described in Part Two of this bulletin. In addition, the student must have passed a qualifying examination in some programs.

Specific Requirements for the Master of Arts Degree in Mathematics

(Major Code: 17011)

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree as described in Part Two of this bulletin, the student must meet the following requirements:

1. Complete 30 units of approved 500, 600, and 700 level courses, of which at least 24 units must be in mathematics (including computer science). At least 21 units must be at the 600 level or above. Mathematics 600, 601, and 602 may not be part of this degree. No more than six units of Mathematics 797 and 798 will be accepted toward the degree.
2. Among the 30 units of coursework, students must include at least two courses in the area of algebra chosen from courses 623, 627A, 627B, and at least two courses in analysis chosen from courses 630A, 630B, 631A, 631B.
3. Before entering the program, students should have completed the following courses or their equivalents: Mathematics 521B, 524, 532, 534B. If a student has not had these courses before entering the program, they must be taken during the first year. (A maximum of two of these courses may be applicable toward the degree course requirements.)
4. With departmental approval, students may select Plan A and complete Mathematics 799A or Plan B requiring a written comprehensive examination based on materials to be selected by the department from among Mathematics 623, 627A, 627B, 630A, 630B, 631A, 631B.

   Plan A is encouraged for most students since it provides an introduction to independent reading and is a natural pathway to independent research.

Specific Requirements for the Master of Science Degree in Applied Mathematics

(Major Code: 17031)

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree described in Part Two of this bulletin, the student must meet the following requirements:

1. Have completed before entering the program, the following courses or their equivalents: Mathematics 524, 534A, 534B, 541; Statistics 551A; and programming proficiency in a computer language. Admission to the program as conditionally classified may be granted without some of the coursework above, contingent on the student removing any deficiencies by the end of the first year in the program. (These courses will not count toward the degree course requirements.)
2. Complete a minimum of 30 units of approved 500-, 600- and 700-numbered courses. All programs must include at least 21 units in mathematical sciences (with the possible exception of a student who shows an interest in mathematical modeling) and at least 18 units selected from 600- and 700-numbered courses. No more than six units in Mathematics 797 and 798 will be accepted for credit toward the degree. A program of study must be approved by the graduate adviser.
3. With departmental approval, the student may select Plan A, and complete Mathematics 799A, Thesis. The student must have an oral defense of their thesis or research, open to the public. If Plan B is elected, the student must complete three units of Mathematics 797, Research, and pass the written Comprehensive Examination in Applied Mathematics.

Concentration in Mathematical Theory of Communication Systems

This concentration focuses on the areas of mathematics relevant to the processing of information by digital or analog methods through electromagnetic or opto-acoustic channels. In addition to meeting the requirements for classified standing in the Master of Science program in applied mathematics, students pursuing this concentration will complete the following 18 units of core courses: Mathematics 522, 525, 623, 626, 667, 668. Nine units of electives must be chosen with the approval of the graduate adviser. Recommended electives are Mathematics 534B, 543, 627A-627B, 630A-630B, 631A-631B, 693A, and 693B. Depending on the student's academic background, the graduate adviser may approve elective courses in computer science, statistics, or electrical engineering. Courses outside mathematics that pertain to this concentration include Computer Science 574, Statistics 553, Electrical Engineering 558, 652, 653, and 658. Either Mathematics 797, Research, or 799A, Thesis, is required of all students in this degree program.

Courses Acceptable on Master's Degree Programs in Applied Mathematics, Computer Science, Mathematics, and Statistics (MATH)

General

UPPER DIVISION COURSES

NOTE: Proof of completion of prerequisites required for all upper division courses: Copy of transcript.

509. Computers in Teaching Mathematics (3)

Two lectures and three hours of laboratory.

Prerequisite: Mathematics 252.

Solving mathematical tasks using an appropriate computer interface, and problem-based curricula. Intended for those interested in mathematics teaching.

510. Introduction to the Foundations of Geometry (3) I, II

Prerequisite: Mathematics 122 or 151.

The foundations of Euclidean and hyperbolic geometries. Highly recommended for all prospective teachers of high school geometry.

511. Projective Geometry (3)

Prerequisite: Mathematics 254.

Geometry emphasizing relationships between points, lines, and conics. Euclidean geometry and some non-Euclidean geometrics as special cases of projective geometry.

512. Non-Euclidean Geometry (3)
Prerequisite: Mathematics 122 or 151.
History of attempts to prove the fifth postulate; emphasis on plane synthetic hyperbolic geometry; brief treatment of other types of non-Euclidean geometry.

521A. Abstract Algebra (3) I, II
Prerequisites: Mathematics 245 and 252.
Abstract algebra, including elementary number theory, groups, and rings.

521B. Abstract Algebra (3) II
Prerequisite: Mathematics 521A.
Continuation of Mathematics 521A. Rings, ideals, quotient rings, unique factorization, noncommutative rings, fields, quotient fields, and algebraic extensions.

522. Number Theory (3) I
Prerequisites: Mathematics 245 and 252.
Theory of numbers to include congruences, Diophantine equations, and a study of prime numbers; cryptography.

523. Mathematical Logic (3)
Prerequisite: Mathematics 245.
Propositional logic and predicate calculus. Rules of proof and models. Completeness and the undecidability of arithmetic. Not open to students with credit in Philosophy 521.

524. Linear Algebra (3) I, II
Prerequisites: Mathematics 245 and 254; or 342A.
Vector spaces, linear transformations, orthogonality, eigenvalues and eigenvectors, normal forms for complex matrices, positive definite matrices and congruence.

525. Algebraic Coding Theory (3) II
Prerequisite: Mathematics 254.
Linear codes, perfect and related codes, cyclic linear codes, BCH codes, burst error-correcting codes.

531. Partial Differential Equations (3) I
Prerequisites: Mathematics 252 and 337.
Boundary value problems for heat and wave equations: eigenfunction expansions, Sturm-Liouville theory and Fourier series. D'Alembert's solution to wave equation; characteristics. Laplace's equation, maximum principles, Bessel functions.

532. Functions of a Complex Variable (3)
Prerequisite: Mathematics 252.
Analytic functions, Cauchy-Riemann equations, theorem of Cauchy, Laurent series, calculus of residues, and applications.

533. Vector Calculus (3)
Prerequisite: Mathematics 254 or 342A.
Scalar and vector fields; gradient, divergence, curl, line and surface integrals: Green's, Stokes' and divergence theorems. Green's identities. Applications to potential theory or fluid mechanics or electromagnetism.

534A. Advanced Calculus I (3) I, II, S
Prerequisites: Mathematics 245 and 254; or 342A.
Completeness of the real numbers and its consequences, sequences of real numbers, continuity, differentiability and integrability of functions of one real variable.

534B. Advanced Calculus II (3) II
Prerequisite: Mathematics 534A.
Series and sequences of functions and their applications, functions of several variables and their continuity, differentiability and integrability properties.

535. Introduction to Topology (3) I
Prerequisite: Mathematics 534A.
Topological spaces. Functions, mappings, and homeomorphisms. Connectivity, compactness. Metric spaces.

537. Ordinary Differential Equations (3)
Prerequisite: Mathematics 337.
Theory of ordinary differential equations: existence and uniqueness, dependence on initial conditions and parameters, linear systems, stability and asymptotic behavior, plane autonomous systems, series solutions at regular singular points.

541. Introduction to Numerical Analysis and Computing (3) I, II, S
Prerequisites: Mathematics 254 or 342A; and Computer Science 106 or 107 or 205 or Engineering 120.
Solution of equations of one variable, direct methods in numerical linear algebra, least squares approximation, interpolation and uniform approximation, quadrature.

542. Introduction to Numerical Solutions of Differential Equations (3) II
Prerequisites: Mathematics 337 and 541.
Initial and boundary value problems for ordinary differential equations. Partial differential equations. Iterative methods, finite difference methods, and the method of lines.

543. Numerical Matrix Analysis (3)
Prerequisite: Mathematics 541.
Gaussian elimination, LU factorizations and pivoting strategies. Direct and iterative methods for linear systems. Iterative methods for diagonalization and eigensystem computation. Tridiagonal, Hessenberg, and Householder matrices. The QR algorithm.

544. Computational Finance (3)
Prerequisites: Mathematics 531 and Statistics 550.
Numerical procedures for evaluating financial derivatives. Discretization of partial differential equations. Monte Carlo simulation techniques.

561. Applied Graph Theory (3)
Prerequisite: Mathematics 245 or 254.
Undirected and directed graphs, trees, Hamiltonian circuits, classical problems of graph theory including applications to linear systems.

562. Mathematical Methods of Operations Research (3) II
Prerequisites: Mathematics 252 and 254.
Theory and applications concerned with optimization of linear and non-linear functions of several variables subject to constraints, including simplex algorithms, duality, applications to game theory, and descent algorithms.

579. Combinatorics (3)
Prerequisite: Mathematics 245.
Permutations, combinations, generating functions, recurrence relations, inclusion-exclusion counting. Polya's theory of counting, other topics and applications.

580. Risk Management: Stocks and Derivative Securities (3)

Prerequisite: Mathematics 337, Statistics 550, or 551A.

Theory of derivative securities with focus on evolution of stock prices and pricing of options.

581. Risk Management: Portfolio Selection and Other Features of Finance Markets (3)

Prerequisite: Mathematics 337, Statistics 550 or 551A, Mathematics 580.

Derivatives and term structures, method of principal components, theory of portfolio optimization, some numerical methods.

596. Advanced Topics in Mathematics (1-4) I, II

Prerequisite: Consent of instructor.

Selected topics in classical and modern mathematical sciences. May be repeated with the approval of the instructor. See Class Schedule for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit of six units of 596 applicable to a bachelor's degree. Maximum combined credit of six units of 596 and 696 applicable to a 30-unit master's degree.

General
GRADUATE COURSES

623. Linear Algebra and Matrix Theory (3)

Prerequisite: Mathematics 524.

Characteristic and minimal polynomials, Cayley-Hamilton theorem, canonical forms, hermitian matrices, Sylvester's law, norms, singular values, stability, non-negative matrices.

626. Cryptography (3)

Prerequisite: Mathematics 521A or 522.

Design of secure cryptosystems with applications. Classical and public key cryptosystems. Primality testing, factoring, discrete log problem, and knapsack problem.

627A. Modern Algebra I (3)

Prerequisite: Mathematics 521B.

Group theory, including isomorphism theorems, permutation groups, and simplicity of An, finite abelian groups, and Sylow theorems. Rings, ideals, principal ideal domains, and unique factorization. (Formerly numbered Mathematics 621, 624.)

627B. Modern Algebra II (3)

Prerequisite: Mathematics 627A.

Modules and the Wedderburn-Artin theorem, field extensions, splitting fields, Galois theory, finite fields, the fundamental theorem of algebra. (Formerly numbered Mathematics 622, 624.)

630A-630B. Functions of a Real Variable (3-3)

Prerequisites: Mathematics 524 and 534B. Mathematics 630A is prerequisite to Mathematics 630B.

Lebesgue measure and integration, metric spaces, Banach spaces, Hilbert spaces, spectral theory.

631A-631B. Functions of a Complex Variable (3-3)

Prerequisites: Mathematics 532 and 534B. Mathematics 631A is prerequisite to 631B.

Theory of analytic functions. Elementary functions and power series, Cauchy's theorem and its consequences. Entire functions, conformal mappings, Riemann mapping theorem. Harmonic functions.

636. Mathematical Modeling (3) I

Prerequisites: Mathematics 254 and 337 or Mathematics 342A and 342B or Engineering 280.

Advanced models from the physical, natural, and social sciences. Emphasis on classes of models and corresponding mathematical structures. (Formerly numbered Mathematics 536.)

637. Theory of Ordinary Differential Equations (3)

Prerequisites: Mathematics 524, 532, 534B, and either Mathematics 531 or 537.

Existence, uniqueness, and continuation of solutions from an advanced standpoint. Linear systems and their stability and asymptotic behavior, regular and irregular singularities, and regular boundary value problems.

662. Advanced Optimization Theory (3)

Prerequisites: Mathematics 524 and 562.

Formulating the optimization problem and constructing proper models. Sequential optimization: linear programming, integer programming, dynamic programming, nonlinear programming. Duality theory and sensitivity analysis. Sample applications and numerical implementation.

663. Methods of Applied Analysis (3)

Prerequisite: Mathematics 534B.

Functional analysis with applications to applied mathematics. Metric and normed linear spaces, bounded and compact operators, inner product and Hilbert spaces, self-adjoint operators and orthogonal expansions.

667. Mathematical Aspects of Systems Theory (3)

Prerequisites: Mathematics 524 and 537.

Linear and nonlinear systems, nonlinear differential equations, equilibrium equations. Linearization, state transition matrix, stability theory, feedback control systems.

668. Applied Fourier Analysis (3)

Prerequisites: Mathematics 524, 534A; 532 or 534B.

Discrete and continuous Fourier transform methods with applications to statistics and communication systems.

693A. Advanced Numerical Analysis (3)

Prerequisites: Mathematics 524 and 542 or 543.

Numerical optimization, Newton's methods for nonlinear equations and unconstrained minimization. Global methods, nonlinear least squares, integral equations.

693B. Advanced Numerical Analysis (3)

Prerequisites: Mathematics 531, 537, and 693A.

Methods for differential equations. Elliptic and parabolic partial differential equations. Stiff ordinary differential equations.

696. Selected Topics in Mathematical Sciences (3)

Prerequisite: Graduate standing.

Intensive study in specific areas of mathematical sciences. May be repeated with new content. See Class Schedule for specific content. Maximum combined credit of six units of 596 and 696 applicable to a 30-unit master's degree.

720. Seminar (1-3)

Prerequisite: Consent of instructor.

An intensive study in advanced mathematics. May be repeated with new content. See Class Schedule for specific content. Maximum credit six units applicable to a master's degree.

790. Practicum in Teaching of Mathematics (1) Cr/NC

Prerequisite: Award of graduate teaching associateship in mathematics.

Supervision in teaching mathematics. Lecture writing, style of lecture presentation and alternatives, test and syllabus construction, and grading system. Not applicable to an advanced degree. Required for first semester GTA's.

797. Research (1-3) Cr/NC/SP

Prerequisite: Six units of graduate level mathematics.

Research in one of the fields of mathematics. Maximum credit six units applicable to a master's degree.

798. Special Study (1-3) Cr/NC/SP

Prerequisite: Consent of staff; to be arranged with department chair and instructor.

Individual study. Maximum credit six units applicable to a master's degree.

799A. Thesis or Project (3) Cr/NC/SP

Prerequisites: An officially appointed thesis committee and advancement to candidacy.

Preparation of a project or thesis for the master's degree.

799B. Thesis or Project Extension (0) Cr/NC

Prerequisite: Prior registration in Thesis or Project 799A with an assigned grade symbol of SP.

Registration required in any semester or term following assignment of SP in Course 799A in which the student expects to use the facilities and resources of the university; also student must be registered in the course when the completed thesis or project is granted final approval.

Mathematics Education Program (MATH)
GRADUATE COURSES

600. Geometrical Systems (3)

Prerequisites: Mathematics 521A and an upper division course in geometry.

Ordered and affine geometries, decompositions, dilations. Projectivities and projective space. Absolute geometry, isometries, groups generated by inversions.

601. Topics in Algebra (3)

Prerequisites: Mathematics 521A and 534A.

Unique factorization domains, rings and ideals, groups, algebraic field extensions. A course designed for secondary school teachers.

602. Topics in Analysis (3)

Prerequisites: Mathematics 521A and 534A.

Topics in analysis, including the real number system, convergence, continuity, differentiation, the Riemann-Stieltjes integral, complex analysis, designed to give the secondary teacher a broad understanding of the fundamental concepts.

For additional courses useful to mathematicians see the sections under:
Computer Science
Mathematics and Science Education
Statistics