MATHEMATICAL SCIENCES

Undergraduate Program Information
In addition to meeting University and College requirements, students earning a Bachelor of Science in Mathematics must fulfill the core departmental requirements and choose from one of three emphases:

- General,
- Applied Mathematics or
- Actuarial Science and Insurance.

Students must earn a grade of C- or better in all departmental and nondepartmental courses for any degree in the Department of Mathematical Sciences.

Graduate Program Information
The Department of Mathematical Sciences offers graduate instruction leading to the Master of Science degree, and Doctor of Philosophy degree. Possible areas of study are various topics in pure mathematics and applied mathematics, statistics and mathematics education. Students may also pursue an interdisciplinary program of study. Most graduate students in Mathematical Sciences are supported either through teaching assistantships, research assistantships, fellowships, or job opportunities at nearby teaching or research units.

For more information on our programs and facilities, and to learn more about the research interests of the faculty, please see our web site at www.math.nmsu.edu, phone us at (575) 646-3901, or write to:

Graduate Secretary
Department of Mathematical Sciences
NMSU
Las Cruces, NM 88003-8001
Email: gradcomm@nmsu.edu

Students applying for regular admission to graduate study in mathematics are expected to have 24 credits of upper-division courses in mathematics and statistics, including three-credit proof based courses in modern analysis and in modern algebra. Students who do not meet these requirements may be admitted with deficiencies and allowed to complete the requirements at New Mexico State University.

Applications must be submitted online, see http://prospective.nmsu.edu/graduate/apply/. The minimum application to be admitted as a regular graduate student in mathematics includes:

1. a completed Graduate School admission application
2. complete transcripts of all undergraduate and graduate work
3. application fee
4. three letters of recommendation from professors, employers, or others who are qualified to judge potential for graduate work in mathematics
5. a one-page statement of educational objectives

Although GRE subject test scores are not required for admission, applicants are encouraged to submit them, if available. The test scores may be used to help allocate available teaching assistantships among entering students.

To ensure full consideration for admission, candidates should submit their applications by the following deadlines.

### Application Deadlines-Domestic Applicants

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<tr>
<th>Semester</th>
<th>Admission Only</th>
<th>Admission/Financial Aid</th>
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<td>Fall</td>
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### Application Deadlines-International Applicants

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### Degrees for the Department

Mathematics - Bachelor of Science (http://catalogs.nmsu.edu/nmsu/arts-sciences/mathematical-sciences/mathematics-bachelor-science)

Applied Mathematics - Supplemental Major (http://catalogs.nmsu.edu/nmsu/arts-sciences/mathematical-sciences/applied-mathematics-supplemental-major)

Mathematics - Master of Science (http://catalogs.nmsu.edu/nmsu/arts-sciences/mathematical-sciences/mathematics-master-science)

Mathematics - Doctor of Philosophy (http://catalogs.nmsu.edu/nmsu/arts-sciences/mathematical-sciences/mathematics-doctor-philosophy)

### Minors for the Department

Mathematics - Undergraduate Minor (http://catalogs.nmsu.edu/nmsu/arts-sciences/mathematical-sciences/mathematics-undergraduate-minor)

**Professor, Joseph Lakey, Department Head**

**Professors** Baggett, Barany, Bezhanishvili, DeBlassie, Giorgi, Harding, Lakey, Lodder, Morandi, Olberding, Smits, Wang; **Associate Professors** Ballyk, Fouli, Salamanca-Riba, Stanford, Tian; **Assistant Professors** Cahill, Chen, Contreras, Montaño; **College Professors** Fulte, Mostafa, Stuart, Zimmerman; **College Associate Professors** White-Hosford; **College Assistant Professors** Ausbrooks, Villaverde; **College Instructor** Reece


Mathematics Courses

MATH 101. General Supplemental Instruction I
1 Credit
Corequisite(s): MATH 120.

MATH 102. General Supplemental Instruction II
1 Credit
Corequisite(s): MATH 121G.

MATH 107. Topics in Mathematics
1-3 Credits
Topics to be announced in the Schedule of Classes. Maximum of 3 credits per semester. Total credit not to exceed 6 credits. Community Colleges only.
Prerequisite: consent of instructor.

MATH 111. Fundamentals of Elementary Mathematics I
3 Credits
Numbers and the four operations of arithmetic. Understanding and comparing multiple representations of numbers and operations, in particular how these representations build from whole numbers to integers to fractions and decimals. Applying properties of numbers and operations in contextual situations. Reasoning, communicating, and problem solving with numbers and operations. Applications to ratio, and connections with algebra. Taught primarily through student activities and investigations. Restricted to: EDUC, EPAR, EED, ECED majors.
Prerequisite(s): ENGL 111G and grade of C or better in MATH 120.

MATH 112G. Fundamentals of Elementary Math II
3 Credits
Geometry and measurement. Multiple approaches to solving problems and understanding concepts in geometry. Analyzing and constructing two- and three-dimensional shapes. Measurable attributes, including angle, length, area, and volume. Understanding and applying units and unit conversions. Transformations, congruence, and similarity. Scale factor and similarity. Coordinate geometry and connections with algebra. Reasoning and communicating about geometric concepts. Taught primarily through student activities and investigations.
Prerequisite(s): C or better in MATH 111.

MATH 120. Intermediate Algebra
3 Credits
Linear and algebraic functions as they arise in real world problems. Exponential and logarithmic functions. Equations and inequalities and their solutions considered symbolically, graphically and numerically.
Prerequisite: adequate score on the Mathematics Placement Examination.

MATH 121G. College Algebra
3 Credits
Fundamental concepts of functions, including algebraic and graphical properties. Fitting functions to data. Finding zeroes and extreme values. Solving systems of equations.
Prerequisites: Adequate math placement score or C or better in MATH 120.

MATH 142G. Calculus for the Biological and Management Sciences
3 Credits (2+2P)
Review of functions. Derivatives, exponential and logarithmic functions, antiderivatives and indefinite integrals, basic ordinary differential equations and growth models, with an emphasis on applications. Includes a significant writing component.
Prerequisite(s): C or better in MATH 121G.

MATH 190G. Trigonometry and Precalculus
4 Credits (3+2P)
Elementary functions used in the sciences with emphasis on trigonometric functions and their inverses. Polar coordinates. Complex numbers and Euler’s formula. Analytic geometry and vectors.
Prerequisite: adequate score on Mathematics placement exam or a C or better in MATH 121G.

MATH 191G. Calculus and Analytic Geometry I
4 Credits
Limits and continuity, theory and computation of derivatives, applications of derivatives, extreme values, critical points, derivative tests, L’Hopital’s Rule.
Prerequisite(s): C or better in MATH 190G.

MATH 192G. Calculus and Analytic Geometry II
4 Credits
Riemann sums, the definite integral, antiderivatives, fundamental theorems, techniques of integration, applications of integrals, improper integrals, Taylor polynomials, sequences and series, power series and Taylor series.
Prerequisite(s): C or better in MATH 191G.

MATH 192GH. Calculus and Analytic Geometry II Honors
4 Credits (3+1P)
A more advanced treatment of the material of MATH 192G with additional topics. Consent of Instructor required. Restricted to Las Cruces campus only.
Prerequisite(s): Consent of Department.

MATH 200. Directed Study
1-3 Credits
May be repeated for a maximum of 6 credits. Graded S/U.
Prerequisite: consent of the instructor.

MATH 210G. Mathematics Appreciation
3 Credits
Mathematics and its role in the development and maintenance of civilization.
Prerequisites: High school algebra, and an adequate score on the Mathematics Placement Examination.

MATH 215. Fundamentals of Elementary Mathematics III
3 Credits
Probability, statistics, ratios, and proportional relationships. Experimental and theoretical probability. Collecting, analyzing, and displaying data, including measurement data. Multiple approaches to solving problems involving proportional relationships, with connections to number and operation, geometry and measurement, and algebra. Understanding data in professional contexts of teaching. Taught primarily through student activities and investigations.
Prerequisite(s): C or better in MATH 112.

MATH 235. Calculus for the Technical Student I
3 Credits
Intuitive differential and integral calculus with applications to engineering.
Prerequisite: C or better in MATH 190G.
MATH 236. Calculus for the Technical Student II  
3 Credits  
A continuation and extension of the material in MATH 235.  
Prerequisite(s): C or better in MATH 235 or in MATH 192G.

MATH 279. Introduction to Higher Mathematics  
3 Credits  
Logic; sets, relations, and functions; introduction to mathematical proofs.  
Prerequisite(s): C- or better in MATH 192.

MATH 280. Introduction to Linear Algebra  
3 Credits  
Systems of equations, matrices, vector spaces and linear transformations. Applications to computer science.  
Prerequisite(s): Grade of C- or better in MATH 192G.

MATH 291G. Calculus and Analytic Geometry III  
3 Credits  
Vector algebra, directional derivatives, approximation, max-min problems, multiple integrals, applications, cylindrical and spherical coordinates, change of variables.  
Prerequisite: grade of C or better in MATH 192G.

MATH 300. Readings  
1-3 Credits  
A selection of readings and reports in the mathematical sciences, the breadth and depth of which is deemed to fit the needs of the student. Graded S/U.  
Prerequisite: consent of instructor.

MATH 313. Fundamentals of Algebra and Geometry I  
3 Credits (3+1P)  
Covers algebra combined with geometry based on measurements of distance (metric geometry). Secondary mathematics education majors may take course as a math elective. MATH 313 does not substitute for other required math courses. Does not fulfill requirements for major in mathematics.  
Prerequisites: MATH 111 and MATH 112G.

MATH 316. Calculus with Hands-on Applications  
3 Credits  
This course, primarily for prospective teachers, is taught in an interactive laboratory format. Students design and construct physical objects for which the planning stage requires calculus techniques. All numerical computations are carried out on graphing calculators. Meets simultaneously with MATH 516, primarily for practicing teachers. Secondary math education majors may take course as a math elective. MATH 316 does not fulfill requirements for majors in mathematics.  
Consent of instructor required.

MATH 331. Introduction to Modern Algebra  
3 Credits  
Elements of abstract algebra, including groups, rings and fields.  
Prerequisite: C or better in MATH 279 and MATH 280.

MATH 332. Introduction to Analysis  
3 Credits  
Development of the real numbers, a rigorous treatment of sequences, limits, continuity, differentiation, and integration.  
Prerequisite: C or better in MATH 192G and MATH 279.

MATH 337. Introduction to Numerical Methods  
3 Credits  
Basic numerical methods for interpolation, approximation, locating zeros of functions, integration, and solution of linear equations. Computer-oriented methods will be emphasized.  
Prerequisite: grade of C or better in MATH 192G and some programming experience.

MATH 391. Vector Analysis  
3 Credits  
Calculus of vector valued functions, Green’s and Stokes’ theorems and applications.  
Prerequisite: grade of C or better in MATH 291G.

MATH 392. Introduction to Ordinary Differential Equations  
3 Credits  
Introduction to differential equations and dynamical systems with emphasis on modeling and applications. Basic analytic, qualitative and numerical methods. Equilibria and bifurcations. Linear systems with matrix methods, real and complex solutions.  
Prerequisite: C or better in MATH 192G or B or better in MATH 236.

MATH 400. Undergraduate Research  
1-3 Credits  
May be repeated for a maximum of 6 credits. Graded S/U.  
Prerequisite: consent of faculty member.

MATH 401. Special Topics  
1-3 Credits (1-3)  
Specific subjects to be announced in the Schedule of Classes. May be used to fulfill a course requirement for the mathematics major. May be repeated up to 12 credits. Consent of Instructor required.  
Prerequisite(s): Consent of instructor.

MATH 411V. Great Theorems: The Art of Mathematics  
3 Credits  
Adopts the view of mathematics as art, using original sources displaying the creation of mathematical masterpieces from antiquity to the modern era. Original sources are supplemented by cultural, biographical, and mathematical history placing mathematics in a broad human context.  
Prerequisites: Grades of B or better in MATH 192G and any upper division MATH/STAT course, with overall GPA of 3.2 or better, or consent of instructor.

MATH 421. Financial Mathematics I  
3 Credits  
Types of derivatives, forwards and futures, options, returns and payoffs, Arrow-Debre, complete and incomplete markets, the one period model, the binomial option pricing model, binomial trees, martingales and sub martingales, Brownian motion, stochastic integrals, the Ito integral, Ito’s dilemma, the Black-Scholes model, the Black-Scholes formula, European options, American options, free boundary problems, variational inequalities. This course is offered simultaneously with MATH 521.  
Prerequisite(s): C or better in STAT 371 and either MATH 280 or MATH 480 or consent of instructor.

MATH 422. Financial Mathematics II  
3 Credits  
Bonds, swaps, exotic options, barrier options, Asian options, look back options, options with transaction costs, Fokker Plank theory, computing expectations, the Heath-Jarrow- Morton theorem, the Ho-Lee model, stochastic volatility models, exponential-affine models, numerical methods. This course is offered simultaneously with MATH 522.  
Prerequisite: C or better in MATH 421 or consent of instructor.
MATH 423. Numerical Optimization and Applications to Financial Mathematics
3 Credits
Dynamic optimization of a monopolist, trading off inflation and unemployment, the optimal adjustment of labor demand, infinite planning horizon, the optimal investment path of a firm, the optimal social saving behavior, phase-diagram analysis, optimal control theory, the political business cycle, the dynamics of a revenue-maximizing firm, economic examples of state-space constraints. This course is offered simultaneously with MATH 523.
Prerequisite(s): C- or better in MATH 421.

MATH 451. Introduction to Differential Geometry
3 Credits
Applies calculus to curves and surfaces in three dimensional Euclidean space.
Prerequisite(s): C- or better in each of MATH 280 and MATH 391, or consent of instructor.

MATH 452. Foundations of Geometry
3 Credits
Topics in projective, axiomatic Euclidean or non-Euclidean geometries. Restricted to: Main campus only.
Prerequisite(s): C or better in MATH 331 or MATH 332.

MATH 453. Introduction to Topology
3 Credits
Introduction to topological spaces and metric spaces, with connections to analysis, geometry, and the classification of surfaces.
Prerequisite(s): C- or better in MATH 332 or consent of instructor.

MATH 454. Mathematical Logic
3 Credits
Propositional calculus and the first order predicate calculus, including Gödel's completeness theorem for the latter, and additional topics at the option of the instructor.
Prerequisite(s): C or better in MATH 331 or MATH 332, or consent of instructor.

MATH 455. Elementary Number Theory
3 Credits
Covers primes, congruences and related topics.
Prerequisite: grade of C or better in MATH 331 or consent of instructor.

MATH 457. Applications of Modern Algebra
3 Credits
Topics may include coding theory, cryptography, graph theory, or symmetry groups. May be repeated up to 9 credits.
Prerequisite(s): C or better in MATH 331 or MATH 332, or consent of instructor.

MATH 459. Survey of Geometry
3 Credits
Basic concepts of Euclidean geometry, ruler and compass constructions. May include topics in non-Euclidean geometry. For non-math majors. Restricted to: Main campus only.
Prerequisite(s): C or better in MATH 331 or MATH 332.

MATH 466. Lattice Theory
3 Credits
Introduction to partially ordered sets, distributive, modular, and Boolean lattices.
Prerequisite(s): C- or better in MATH 330 or C- or better in MATH 331 or C- or better in MATH 332 or consent of instructor.

MATH 471. Complex Variables
3 Credits
A first course in complex function theory, with emphasis on applications.
Prerequisite(s): C- or better in MATH 391 or C- or better in both MATH 392 and MATH 291.

MATH 472. Fourier Series and Boundary Value Problems
3 Credits
Fourier series and methods of solution of the boundary value problems of applied mathematics.
Prerequisite(s): C- or better in MATH 392.

MATH 473. Calculus of Variations and Optimal Control
3 Credits
Euler’s equations, conditions for extrema, direct methods, dynamic programming, and the Pontryagin maximal principle.
Prerequisite(s): C- or better in MATH 392.

MATH 480. Matrix Theory and Applied Linear Algebra
3 Credits
An application driven course, whose topics include rectangular systems, matrix algebra, vector spaces and linear transformations, inner products, and eigenvalues and eigenvectors. Applications may include LU factorization, least squares, data compression, QR factorization, singular value decomposition, and search engines.
Prerequisite(s): C or better in any 300-level course with a MATH or STAT prefix.

MATH 481. Advanced Linear Algebra
3 Credits
Rigorous treatment of vector spaces and linear transformations including canonical forms, spectral theory, inner product spaces and related topics.
Prerequisite: grade of C or better in MATH 331.

MATH 491. Introduction to Real Analysis I
3 Credits
Rigorous discussion of the topics introduced in calculus. Sequences, series, limits, continuity, differentiation.
Prerequisite: grade of C or better in MATH 332 or consent of instructor.

MATH 492. Introduction to Real Analysis II
3 Credits
Continuation of MATH 491. Integration, metric spaces and selected topics.
Prerequisite(s): C- or better in MATH 491 or consent of instructor.

MATH 498. Directed Reading
1-6 Credits
May be repeated for a maximum of 6 credits. Graded S/U.

MATH 501. Introduction to Differential Geometry
3 Credits
Same as MATH 451 with additional work for graduate students.

MATH 502. Foundations of Geometry
3 Credits
Same as MATH 452 with additional assignments for graduate students.

MATH 503. Introduction to Topology
3 Credits
Same as MATH 453 with additional assignments for graduate students.

MATH 504. Mathematical Logic
3 Credits
Same as MATH 454 with additional assignments for graduate students.

MATH 505. Elementary Number Theory
3 Credits
Same as MATH 455 with additional assignments for graduate students.
MATH 506. Lattice Theory  
3 Credits  
Same as MATH 466 with additional assignments for graduate students.

MATH 507. Applications of Modern Algebra  
3 Credits  
Taught with MATH 457 with additional work for graduate students. May be repeated up to 9 credits.

MATH 509. Information Theory  
3 Credits  
This class is a study of Shannon's measure of information and discusses mutual information, entropy, and channel capacity, the noiseless source coding theorem, the noisy channel coding theorem, channel coding and random coding bounds, rate-distortion theory, and data compression. Restricted to: Main campus only. Crosslisted with: E E 586
Prerequisite(s): E E 571 or STAT 515.

MATH 511. Fundamentals of Elementary Mathematics I  
3 Credits (3+1P)  
Topics from real numbers, geometry, measurement, and algorithms, incorporating calculator technology. Intended for K-8 teachers. As part of course students mentor MATH 111 undergraduates. Does not fulfill degree requirements for M.S. in mathematics.

MATH 512. Fundamentals of Elementary Mathematics II  
3 Credits (3+1P)  
Real numbers, geometry, and statistics, incorporating calculator technology. Intended for K-8 teachers. Students serve as mentors to MATH 112 undergraduates. Does not fulfill degree requirements for M.S. in mathematics.

MATH 513. Fundamentals of Algebra and Geometry I  
3 Credits (3+1P)  
Algebra and metric geometry, incorporating appropriate calculator technology. Intended for K-8 teachers. Students serve as mentors to MATH 313 undergraduates. Does not fulfill degree requirements for M.S. in mathematics.

MATH 516. Calculus with Hands-on Application  
3 Credits  
This course, primarily for in-service teachers, is taught in an interactive laboratory format. Students design and construct physical objects for which the planning stage requires calculus techniques. All numerical computations are carried out on graphing calculators. Meets simultaneously with Math 316, primarily for prospective teachers. Does not fulfill degree requirements for M.S. in Mathematics.
Prerequisite(s): MATH 511 and MATH 512 or consent of instructor.

MATH 517. Complex Variables  
3 Credits  
Same as MATH 471 with additional work for graduate students.

MATH 518. Fourier Series and Boundary Value Problems  
3 Credits  
Same as MATH 472 with additional work for graduate students.

MATH 519. Calculus of Variations and Optimal Control  
3 Credits  
Same as MATH 473 with additional work for graduate students.

MATH 521. Financial Mathematics I: Portfolio Optimization  
3 Credits  
Complete and incomplete markets, optimal investment paths, dynamic optimization, the Black-Scholes model, European options, American options. May be repeated up to 3 credits.
Prerequisite(s): STAT 515.

MATH 522. Financial Mathematics II  
3 Credits  
Prerequisite: MATH 521.

MATH 523. Numerical Optimization and Applications to Financial Mathematics  
3 Credits  
Dynamic optimization of a monopolist, trading off inflation and unemployment, the optimal adjustment of labor demand, infinite planning horizon, the optimal investment path of a firm, the optimal social saving behavior, phase-diagram analysis, optimal control theory, the political business cycle, the dynamics of a revenue-maximizing firm, economic examples of state-space constraints. This course is offered simultaneously with MATH 423.
Prerequisite: MATH 521.

MATH 525. Advanced Linear Algebra  
3 Credits  
Same as MATH 481 with additional work for graduate students. May be repeated up to 3 credits.

MATH 527. Introduction to Real Analysis I  
3 Credits  
Same as MATH 491 with additional work for graduate students.

MATH 528. Introduction to Real Analysis II  
3 Credits  
Same as MATH 492 with additional work for graduate students.

MATH 530. Special Topics  
1-3 Credits  
Specific subjects to be announced in the Schedule of Classes. May be for unlimited credit with approval of the department.

MATH 531. Ordinary Differential Equations  
3 Credits  
Linear algebra and linear ordinary differential equations, existence and uniqueness of solution, smooth dependence on initial conditions, flows, introduction to smooth dynamical systems. May be repeated up to 3 credits.
Prerequisite(s): MATH 527, or consent of instructor.

MATH 532. Partial Differential Equations  
3 Credits  
The basic equations of mathematical physics. Elliptic, hyperbolic, and parabolic equations. Characteristic surfaces. Well-posed problems. May be repeated up to 3 credits.
Prerequisite(s): MATH 527 or consent of instructor.

MATH 540. Directed Reading  
1-6 Credits  
May be repeated for a maximum of 6 credits. Consent of instructor required. Graded: S/U.

MATH 541. Topology I  
3 Credits  
Connectedness and compactness of topological spaces, introduction to the quotient topology, elementary homotopy theory; the fundamental group, the Seifert-van Kampen theorem
Prerequisite(s): MATH 525 and MATH 528, or consent of instructor.
MATH 542. Topology II  
3 Credits  
Covering spaces and their classification, singular homology, degree theory, Brouwer's fixed point theorem, CW-complexes and cellular homology, and other applications.  
Prerequisite(s): MATH 541 or consent of instructor.

MATH 555. Differentiable Manifolds  
3 Credits  
Differentiable structures, tangent bundles, vector fields and differential equations. Additional topics may include differential forms, De Rham cohomology, Riemannian geometry, and topics chosen by the instructor. May be repeated for a maximum of 9 credits. Consent of instructor required.  
Prerequisite(s): MATH 525 and MATH 528, or consent of instructor.

MATH 557. Axiomatic Set Theory  
3 Credits  
A detailed study of Zermelo-Fraenkel and Bernays set theories.  
Prerequisite: MATH 504 or equivalent.

MATH 562. History and Theories of Mathematics Education  
3 Credits  
A study of the history of the mathematics taught in American schools, including an examination of authentic original textbooks and the changes in their content and the approach to the subject over time, together with writings of people who have influenced the development and changes of mathematics education. Theories of learning mathematics, and current issues in mathematics education.  
Prerequisite(s): Restricted to graduate students.

MATH 563. Algebra with Connections  
3 Credits  
Connections between Algebra and other K-12 curriculum strands, especially Algebra and Probability / Data Analysis. Apply algebraic modeling and reasoning to a variety of mathematical problem solving situations. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.  
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 564. From Number to Algebra  
3 Credits  
The progression from Number to Algebra in the K-12 curriculum as a concrete-to-abstract progression. Key concepts considered across the grade levels include the different uses of variables, equivalence in different contexts, patterns, and ratios. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.  
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 566. Data Analysis with Applications  
3 Credits  
Statistical concepts and terminology in professional uses of data by teachers, such as standardized test score reports and educational research; visual displays of data; measures of variation and central tendency; consideration of how K-12 topics in Data Analysis are developed from one grade level to the next. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.  
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 569. Geometry with Connections  
3 Credits  
The progression from Measurement to Geometry in the K-12 curriculum as a concrete-to-abstract progression. Important concepts such as angle, length, and area progress from concrete, measurable situations to more abstract problems which require reasoning and proof. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.  
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 575. Using Number Throughout the Curriculum  
3 Credits  
Understand number concepts more deeply by seeing many examples of those concepts applied in other content strands. Develop mathematical knowledge and understanding to build a repertoire of ways for students to practice and review basic number skills and concepts as part of later, more advanced courses. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.  
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 581. Algebra 1  
3 Credits  
Examines groups, commutative rings, solvability of polynomials, Galois theory, ruler and compass constructions.  
Prerequisite/corequisite: MATH 525.

MATH 582. Algebra II  
3 Credits  
Group actions, fundamental theorem of finite Abelian groups, Sylow theorems, solvable groups, noncommutative rings, Noetherian rings, unique factorization domains, modules, tensor products.  
Prerequisite: MATH 581.

MATH 583. Introduction to Commutative Algebra and Algebraic Geometry  
3 Credits  
Introduction to the basic notions and techniques of modern algebraic geometry, including the necessary commutative algebra foundation. Topics likely to include algebraic and projective varieties, Nullstellensatz, morphisms, rational and regular functions, local properties. Other topics may include Noether normalization, dimension theory, singularities, sheaves, schemes, Grobner bases. May be repeated up to 9 credits.  
Prerequisite(s): MATH 581 or consent of instructor.

MATH 584. Representation Theory  
3 Credits  
Topics from representation theory of finite or infinite groups. May be repeated for a maximum of 9 credits.  
Prerequisite: consent of instructor.

MATH 585. Universal Algebra  
3 Credits  
Universal algebra and category theory. Theorems of Birkhoff and Tarski relating equational classes, free algebras and their construction through homomorphisms, subalgebras and products. Topics from model theory, sheaf theory and representation by subdirect products. May be repeated for a maximum of 6 credits.  
Prerequisite: consent of instructor.
MATH 586. Nonlinear Dynamics I
3 Credits
Introduction to nonlinear dynamics and deterministic chaos. Core topics include stability and bifurcations; chaos in one dimensional maps; universality and re-normalization group. Further topics include symbolic dynamics, fractals, sensitive dependence on initial data, self-organization and complexity and cellular automata. Knowledge of differential equations and linear algebra is desired. May be repeated up to 6 credits.

MATH 591. Complex Analysis I
3 Credits
Rigorous treatment of complex differentiation and integration, properties of analytic functions, series and Cauchy’s integral representations. May be repeated up to 3 credits.
Prerequisite(s): MATH 528, or consent of instructor.

MATH 593. Measure and Integration
3 Credits
Measure spaces, measurable functions, extension and decomposition theorems for measures, integration on measure spaces, absolute continuity, iterated integrals.
Prerequisite: MATH 528 or consent of instructor.

MATH 594. Real Analysis
3 Credits
Differentiation, Lp spaces, Banach spaces, measure and topology, other selected topics.
Prerequisite: MATH 593.

MATH 599. Master’s Thesis
15 Credits
Thesis.

MATH 600. Doctoral Research
1-15 Credits
Research.

MATH 643. Topology III
3 Credits
Topics may include higher homotopy groups, fibrations, cohomology operations and obstruction theory, spectral sequences, or others chosen by instructor. May be repeated for a maximum of 9 credits.
Prerequisites: MATH 542 or consent of instructor.

MATH 683. Homological Algebra
3 Credits
Basic topics in homological algebra and category theory. May be repeated for a maximum of 9 credits.
Prerequisite: MATH 542 or MATH 582 or consent of instructor.

MATH 695. Introduction to Functional Analysis I
3 Credits
Banach spaces. The three basic principles: uniform boundedness principle, closed graph/open mapping theorems, Hahn-Banach theorem. May be repeated up to 3 credits.
Prerequisite(s): MATH 594, or consent of instructor.

MATH 698. Selected Topics
1-15 Credits
Selected topics.

MATH 700. Doctoral Dissertation
1-15 Credits
Dissertation.

Statistics Courses

STAT 251G. Statistics for Business and the Behavioral Sciences
3 Credits
Techniques for describing and analyzing data; estimation, hypothesis testing, regression and correlation; basic concepts of statistical inference. Crosslisted with: A ST 251G.
Prerequisite(s): C- or better in MATH 120.

STAT 271G. Statistics for Psychological Sciences
3 Credits
Techniques for describing and analyzing data; basic concepts of statistical inference; estimation, hypothesis testing, correlation, and analysis of variance.
Prerequisite(s): C- or better in MATH 120.

STAT 371. Statistics for Engineers and Scientists I
3 Credits
Modern probability and statistics with applications to the engineering sciences.
Prerequisite(s): C- or better in MATH 192.

STAT 400. Undergraduate Research
1-3 Credits
Arrangements must be made with supervising professor before registration. May be repeated for a maximum of 6 credits.

STAT 470. Probability: Theory and Applications
3 Credits
Basic probability distributions including binomial, normal; random variables, expectation; laws of large numbers; central limit theorem.
Prerequisite(s): C- or better in MATH 291 and C- or better in at least one-300 level Math course.

STAT 480. Statistics: Theory and Applications
3 Credits
Point and interval estimation; sufficiency; hypothesis testing; regression; analysis of variance; chi-square tests.
Prerequisite(s): C- or better in STAT 470.

STAT 515. Probability: Theory and Applications
3 Credits
Same as STAT 470 with additional work for graduate students.

STAT 525. Statistics: Theory and Applications
3 Credits
Same as STAT 480 with additional work for graduate students.

STAT 535. Elementary Stochastic Processes
3 Credits
Markov chains, Poisson processes, Brownian motion, branching processes, and queuing processes, with applications to the physical, biological, and social sciences.
Prerequisite: STAT 515 or consent of instructor.

STAT 540. Directed Reading
1-6 Credits
May be repeated for a maximum of 6 credits. Graded S/U.
Prerequisite: consent of instructor and graduate committee.

STAT 562. Foundations of Probability
3 Credits
Probability spaces, expectation and conditional expectation, limit theorems and laws of large numbers.
Prerequisite: MATH 593.
STAT 571. Continuous Multivariate Analysis
3 Credits
Theory and applications of the multivariate normal distribution. May be repeated up to 3 credits. Consent of Instructor required.
Prerequisite(s): STAT 525, or consent of instructor.

STAT 572. Linear Models
3 Credits
Core topics include distribution of quadratic forms, theory of regression, analysis of variance and covariance in linear models. Advanced topics chosen from random and mixed linear models, generalized linear, growth curve, and nonlinear models, quartile and copula regression. May be repeated up to 6 credits.
Prerequisite(s): STAT 571.

STAT 581. Advanced Theory of Statistics I
3 Credits
Testing hypotheses, probability and sufficiency, uniformly most powerful tests, unbiasedness, invariance, and minimax principle.
Prerequisite: STAT 525 or consent of instructor.

STAT 582. Advanced Theory of Statistics II
3 Credits
Estimation of parameters; unbiased estimators; equivariance; Bayes properties; large sample theory and optimality.
Prerequisite: STAT 581 or consent of instructor.

STAT 598. Special Research Problems
1-3 Credits
Individual investigations or consulting programs. Maximum of 3 credits.

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