

## DEPARTMENT OF MATHEMATICS

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### Faculty

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Dr. R. Gompa, Professor  
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Mr. M. Harbour, Assistant Professor  
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The Department of Mathematics in the School of Science and Technology in cooperation with the School of Education offers a program leading to the Master of Science in Teaching (MST) degrees in Mathematics. This department also offers a Master of Science (MS) degree in pure mathematics for Students who seek careers in college or university teaching, government, industry, business, etc.

### Program Objectives

1. To provide quality mathematics training at the master's degree level.
2. To help increase the number of mathematicians qualified to undertake further studies leading to the doctoral degree in the mathematical sciences.
3. To increase the pool of mathematicians seeking to obtain employment in industry, government and academic institutions.

### Degree Programs

The M.S. degree is research oriented and a Thesis is required for graduation. The M.S.T. degree, in general, can be completed with only course work, a Thesis or Project is optional. However, all of the programs are designed to meet academic requirements for students who are interested in seeking degrees beyond the master's or specialist's level. The M.S.T. degree would lead to a Class "AA" Teaching Certificate for students who hold the Class "A" Teaching Certificate. Students who do not hold the Class "A" Teaching Certificate but wish to receive the M.S.T. degree with a Class "AA" Teaching Certificate must first complete the requirements for a Class "A" Teaching Certificate. A student can also receive the M.S.T. degree without seeking the Class "AA" Teaching Certificate. The coursework requirement for

this option is the same with those holding the Class "A" Teaching Certificate.

### Admissions Requirements

Admission to a graduate program in mathematics requires at least 15 semester hours of undergraduate mathematics above the regular calculus sequence and the fulfillment of the admission requirement into graduate studies at Jackson State University, which is an earned Bachelor's degree with a cumulative GPA of at least 3.0 on the 4.0 scale in all undergraduate courses taken at a regional accredited degree granting institution. GRE is not required for admission into any of the Master's degree programs. However, students who are seeking to pursue the doctoral degree are encouraged to take the GRE exams, general and subject area, to increase their chances for competitive admission and financial assistance. These exams can be taken while students are taking courses or after they have completed all coursework.

### Transfer of Credits

A course for which transfer credit is sought must have been completed with a grade of "B" or better. Departmental approval is required.

### Time Limit

Students with adequate mathematics preparation at the undergraduate level will normally take two years to complete any of the Master's degree programs. However, all students must complete their programs within eight years of starting coursework at Jackson State University or elsewhere.

### Master of Science in Mathematics

The department offers programs leading to the M.S. degree in Pure or Applied Mathematics for students who plan on pursuing the doctoral degree or wish to seek careers in college or university teaching, government, industry and the business sector. The programs are designed for persons with adequate background in undergraduate mathematics beyond the calculus sequence.

To receive the M.S. degree a student must be in residence at Jackson State University for at least one semester, complete all degree requirements and must take and pass the Graduate English Competency Exam. If a student's GPA upon completion of all coursework is below 3.33, then such a student is required to take and score at least 70% on a comprehensive exit exam given by the Department.

### The requirements for the M.S. degree are:

1. Thirty six (36) hours are required with a thesis, i.e. ten (10) courses plus six (6) hours for a thesis.
2. A "B" average with no more than one "C" grade is required for graduation.

<u>Required Courses</u>		<b>Semester</b>
<b>Course</b>	<b>Title</b>	<b>Hours</b>
Math 513	Modern Linear Algebra I	3
Math 511	Modern Algebra I	3
Math 531	Real Analysis I	3
Math 541	Complex Analysis I	3
Math 551	Introduction to General Topology I	3
Math 561	Probability and Statistics I	3
Math 599	Thesis	<u>6</u>
	<i>Total Hours</i>	24

The student will fulfill the remaining 12 hours from mathematics electives drawn from a list of pure or applied mathematics courses to match his/her area of concentration. Courses are offered each semester to match each enrolled student's interest. In consultation with an advisor and the Chairperson of the Department, a student must develop a study plan and select sufficient electives from departmental courses to complete degree requirements with a concentration in either pure or applied mathematics. See the list of departmental courses below. A typical study plan for a student with a concentration in applied mathematics who is seeking to pursue a doctoral degree would look like this:

#### **Coursework for Year One**

##### **Fall Semester**

Math 511 - Modern Algebra I  
 Math 513 – Modern Linear Algebra I  
 Math 531 - Real Analysis I

##### **Spring Semester**

Math 577- Ordinary Differential Equations with Applications  
 Math 579- Partial Differential Equations with Applications Math  
 Math 541 - Complex Analysis I

##### **Summer Sessions**

Math 599-Thesis

#### **Coursework for Year Two**

##### **Fall Semester**

Math 551 – Introduction to General Topology I  
 Math 542 - Complex Analysis II  
 Math 532 – Real Analysis II  
 Math 580 - Partial Differential Equations II or  
 Math 599 -Thesis

Extra Coursework and Thesis Defense

##### **Spring Semester**

Math 537 - Introduction to Functional Analysis  
 Math 547- Integral Equations  
 Take the GRE both General and Subject area tests  
 Math 599-Thesis

#### **Master of Science in the Teaching Science and Mathematics Education**

The Science and Mathematics education degree is a master-level degree offered within the College of Science, Engineering, and Technology under the direction of the Department of Mathematics and in cooperation with the College of Education and Human

Development. There are three areas of concentration under the MST. A student can take coursework with concentrations in biology, mathematics or earth sciences. The concentration in mathematics is designed for persons with an adequate background in mathematics and who wish additional preparation for mathematics teaching or mathematics supervision. Degree requirements facilitate obtaining certification via an alternate route and is described in greater detail below, based on certification requirements of the State of Mississippi as stated in Bulletin 130, and upon the state principles and guidelines of the National Council of Teachers of Mathematics, the Mathematics Association of America, and the Mississippi Council of Teachers of Mathematics.

#### **The requirements for the M.S.T. degree with a concentration in mathematics are:**

*The Science and Mathematics Education degree offers concentrations in one of three areas: biology, mathematics or earth science. Coursework specific to biology and earth science are found within their respective department degree program requirements.*

1. Thirty six (36) hours are required with a thesis, i.e. ten (10) courses plus six (6) hours for a thesis.
2. Thirty six (36) hours are required with a project, i.e. eleven (11) courses plus three (3) hours for a project.
3. Thirty six (36) hours are required if neither a thesis nor a project is done.
4. A "B" average with no more than one "C" grade is required for graduation, if a student has two "C" grades, then the student must earn an "A" grade in an additional course.
5. A maximum of eighteen (18) hours can be counted from education classes.

<u>Core Educational</u>		<b>Semester</b>
<b>Courses</b>	<b>Title</b>	<b>Hours</b>
EDFL 511	History and Philosophy of Education (R)	3
EDFL 515	Methods of Educational Research (R)	3
EDFL 514	Elementary Statistics (R*)	3
EDFL 568	Curriculum Methods (R*)	<u>3</u>
	<i>Total Hours</i>	12

(R) - Required

(R\*) - Required for students without an undergraduate Statistics course and it is a prerequisite for EDFL 515.

<u>Required Mathematics Courses</u>		<b>Semester</b>
<b>Courses</b>	<b>Title</b>	<b>Hours</b>
Math 501	Topics in Geometry	3
Math 506	Basic Concepts for Teachers I	3
Math 510	Topics and Issues in Mathematics	3
Math 513	Linear Algebra I	3
Math 511	Abstract Algebra I	3
Math 531	Real Analysis I	<u>3</u>
	<i>Total Hours</i>	18

Any substitute for the above courses must seek the Department of Mathematics approval.

Students who do not hold the Class "A" Teaching Certificate must also complete the following requirements for certification: Take the PRAXIS I Pre-professional Skills Test (PPST) and make the required cut scores on each of the subtests- reading, writing, and mathematics and successfully complete the PRAXIS 11, mathematics Area Examination. Then complete the following pre-teaching required coursework:

EDFL 581	Principles of Measurement	3
EDFL 556	Special Topics: Classroom Management	3
EDFL 500	Secondary Internship(R*)	6
	<i>Total Hours</i>	12

(R\*) - Required and a student must be employed and have a GPA of at least 2.5 for all undergraduate coursework.

After successful completion of the pre-teaching required coursework, the PRAXIS I and PRAXIS 11, the Mississippi Department of Education Office of Teacher Licensure will issue the applicant upon receipt of PRAXIS test scores, a transcript, a completed application, and institutional recommendation a license that is valid for 5 years.

#### Requirements for Option Choices

- Option 1: Math 590 Thesis 6  
 Option 2: Math 584 Independent Study (Project) 3  
 plus 3 hour course selected from List I,  
*or*  
 Option 3: Six hours selected from List I  
 and three hours selected from List II or List III.

Total number of hours for students with Class "A" Teaching Certificate: 36

Total number of hours for students without the Class "A" Teaching Certificate: 48

A student may concentrate in Applied Mathematics by taking the four (4) elective courses from: Math 514, 537, 541, 542, 561, 562, 565, 566, 577, 579, 580, 581, 582, CSC 511, 512, 515, 518, 531 and 561 or Foundation of Mathematics by taking from: Math 503, 512, 535, 541, 542, CSC 511, 512, 515, 518, 531 and 561.

#### List I

1. Math 503 Foundations of Mathematics I
2. Math 504 Foundations of Mathematics II
3. Math 512 Modern Algebra II
4. Math 514 Modern Linear Algebra II
5. Math 532 Real Analysis II
6. Math 541 Complex Analysis I
7. Math 542 Complex Analysis II
8. Math 561 Probability and Statistics I
9. Math 562 Probability and Statistics II

10. Math 551 Introduction to General Topology I
11. Math 552 Introduction to General Topology II
12. Math 581 Number Theory I
13. Math 582 Number Theory II

#### List II

14. Math 505 Mathematics for Secondary Teachers
15. Math 506 Mathematics Concepts for Teachers I
16. Math 507 Mathematics Concepts for Teachers II
17. Math 509 Mathematical Structures
18. Math 519 Topics in Mathematics Education I
19. Math 520 Topics in Mathematics Education II

#### List III

20. CSC 511 Computers and Programming
21. CSC 512 Introduction to Computer Systems and Organization
22. CSC 515 Data Structures and File Management
23. CSC 518 Principles of Operating Systems
24. CSC 531 Computer Simulation Methods and Models
25. CSC 561 Probability and Statistical Inference I

#### Master's Degree in any of the Education Areas with a Concentration in Mathematics Requirements

Students in any of the Master's Degree Programs in the College of Education and Human Development who wish to seek a concentration in Mathematics must meet the following requirements:

1. Satisfaction of the admission requirement in the mathematics graduate programs of three advanced mathematics courses beyond the calculus sequence, or completion of an undergraduate degree program at a regionally accredited institution in Elementary or Secondary Education with a concentration in mathematics.
2. Meet the 18 credit hours requirement in Mathematics as follows:
3. 9 credit hours must be taken from the following courses with a cumulative average of at least a "B":  
 Math 513 -Linear Algebra I, Math 511 - Abstract Algebra I, Math 531 - Real Analysis I or Math 541 -Complex Analysis I.
4. The remaining 9 hours can be taken in any combination of the graduate level mathematics education courses and the general mathematics courses.

#### DESCRIPTION OF COURSES

Mathematics Courses for Education Majors  
**MATH 500 Mathematics for Elementary School Teachers.** (3 Hours) Prerequisite: Approval of department. A course emphasizing content and techniques employed in the teaching of mathematics

in the elementary school. Stress is placed on current trends and philosophy, content and methodologies.

**MATH 501 Topics in Geometry.** (3 Hours) Prerequisite: Approval of department. A survey of geometries and their structures. Emphasis is on both synthetic and analytic methods.

**MATH 502 Topics in Algebra.** (3 Hours) Prerequisite: Approval of department. An amalgamation of classical and modern theory, stressing the synthesis of ideas in areas from equation solvability, special algebraic forms (permutations, combinations, arrangements, binomial and multinomial theorems, partial fractions, progressions, groups, rings, domains of integrality, and ideas of interest).

**MATH 503-504 Foundations of Mathematics I-II** (3-3 Hours): The fundamental elements of set theory and finite mathematical structures; cardinals and ordinals; logical deduction, elements of probability; vectors and matrices, linear programming, theory of games and applications.

**MATH 505 Mathematics for Secondary Teachers** (3 Hours): Prerequisite: Approval of department. The basis of the content, philosophy and methodology employed in the teaching of secondary school mathematics is of prime interest here.

**MATH 506-507 Mathematics Concepts for Teachers I-II** (3-3 Hours): Prerequisite: Approval of department. Higher mathematics for teachers, reviewing the fundamental areas of algebra, geometry and analysis, with stress on rigor and validity of ideas.

**MATH 508 Elementary School Topics** (3 Hours): Special topics and problems of elementary school mathematics and its teaching.

**MATH 509 Mathematical Structures.** (3 Hours) A course surveying the ideas of algebra, geometries, topology, set theory and other areas of interest. The course serves to strengthen the foundations of the learner, as well as to provide a rigorous basis for the areas under discussion.

**MATH 510 Topics and Issues in Mathematics** (3 Hours): This course is designed for in-service teachers who are interested in the renewal of teaching licenses and the pursuit of graduate studies in the teaching of mathematics. Emphasis is on individualized research dealing with the stages of development of mathematics, new trends in the teaching of mathematics, and the exploration of teaching theories resulting from the work of experimental psychologists such as Piaget, Aushel and Bruner. Because of the individualized nature of the course, students with diverse backgrounds in mathematics can be accommodated.

**MATH 517-518 Topics in Mathematics Education I-II** (3-3 Hours) Elementary. Counting and numerical concepts, problem solving, equipment, achievement examinations.

**MATH 519-520 Topics in Mathematics Education I-II** (3-3 Hours): Secondary. Aims and problems, techniques, arousing and maintaining interest, aids and trends, tests and measurements, traditional and non-traditional courses, operation, geometry.

#### Courses for all Graduate Mathematics Majors

**MATH 511-512 Modern Algebra I-II** (3-3 Hours) Groups, (homomorphisms), rings, integral domains, modules and fields, elementary linear algebra, number theory.

**MATH 513-514 Modern Linear Algebra I-II** (3-3 Hours) Vector spaces, matrices, linear transformations, determinants and linear equations. Selected topics on eigenvalues, canonical forms, inner products, inner product spaces, bilinear and quadratic forms.

**MATH 515-516 Advanced Modern Algebra III-IV** (3-3 Hours) Prerequisite: Mathematics 512. Special topics in groups, rings and fields, factorization theory, extensions of rings and fields, modules, elementary theory of fields.

**MATH 521-522 Modern Geometry I-II (3-3 Hours):** Prerequisite: Mathematics 511, concurrent enrollment or approval of department. Historical development; sets and projective planes and geometries; vectors, transformations, axiomatic affine, projective and plane geometry.

**MATH 523-524 Modern Geometry III-IV** (3-3 Hours) Prerequisite: Mathematics 523 or approval of department. Motions and transformations, projective and topological transformations, projective plane, analytic projective geometry; absolute, ordered, affine and hyperbolic geometries; elementary differential geometry, topology of surfaces.

**MATH 525-526 Introduction to Differential Geometry I-II** (3-3 Hours): Prerequisite: Mathematics 523 or approval of department. Curves and surfaces in three dimensions by classical methods, introduction to corresponding problems in n-dimensions involving tensor methods.

**MATH 527-528 Projective Geometry I-II.** (3-3 Hours) Prerequisite: Mathematics 512 or approval of department. The projective plane, polarities and conic sections, affine geometry, projective metrics, non-Euclidean Geometry, spatial geometry.

**MATH 529-530 Systems Analysis I-II.** (3-3 Hours) Prerequisite: Approval of department. An analysis of the numerical and abstract systems of mensuration. Stress is placed on the metric and English systems, conversion analysis and other systems of interest.

**MATH 531-532 Real Analysis I-II.** (3-3 Hours) Prerequisite: Math 511 or approval of department. Metric spaces, regulated functions and integrals; integrals of Riemann and Lebesgue; trigonometrical and Fourier series; differentiation and Stieltjes Integrals.

**MATH 533-534 Advanced Analysis I-II.** (3-3 Hours) Prerequisite: Mathematics 532 or approval of department. Further treatment of limits, continuity, differentiability and integrability of functions of one and more variables. Infinite series and products, power and trigonometric series; selected topics.

**MATH 535-536 Introduction to Measure and Integration I-II.** (3-3 Hours) Prerequisite: Mathematics 531 or approval of department. Lebesgue measure of linear sets, measurable functions, definite

integral, convergence, integration and differentiation, spaces of functions, orthogonal expansions, multiple integrals and the Stieltjes

Integral.

**MATH 537-538 Introduction to Functional Analysis I-II.** (3-3 Hours) Prerequisites: Mathematics 512, 531, or approval of department. Fundamentals of the theory of vector spaces; Banach spaces; Hilbert spaces. Linear functionals and operators in such spaces; spectral resolution of operators, applications.

**MATH 539-540 Introduction to Infinite Series I-II.** (3-3 Hours) Prerequisites: Mathematics 511 and approval of department. Complex numbers, sets and functions; limits and continuity; analytic functions of a complex variable, elementary functions; integration; power and Laurent series, calculus of residues, conformal representation, special topics.

**MATH 541-542 Complex Analysis I-II.** (3-3 Hours) Complex numbers, sets and functions; limits and continuity; analytic functions of a complex variable, elementary functions; integration; power and Laurent series, calculus of residues, conformal representation, special topics.

**MATH 544 Introduction to Entire Functions.** (3 Hours) Prerequisite: Mathematics 541. Entire functions, maximum absolute value and order, zeroes of entire functions, fundamental theorem of algebra, Picard's Little Theorem, algebraic relationships and addition theorem; special theorems and functions.

**MATH 545 Laplace Transforms.** (3 Hours) Prerequisites: Math 534 and approval of department. The Stieltjes Integral; fundamental formulae; moment problem, Tauberian theorems, bilateral Laplace Transform, inversion and representation problems, the Stieltjes Transform.

**MATH 546 Special Functions.** (3 Hours) Prerequisites: Math 535 and approval of department. Infinite products, Gamma and Beta functions, series, polynomials, functions, relations and sets of analysis and differential equations.

**MATH 547-548 Integral Equations I-II.** (3-3 Hours) Prerequisites: Math 534, 542, and approval of department. Theory of Fredholm and Volterra equations; Hilbert-Schmidt theory; singular integral equations and some applications.

**MATH 549-550 Methods In Applied Mathematics I-II.** (3-3 Hours) Prerequisite: Approval of department. Elements of linear algebra; applications to systems of linear variables; function spaces; tensor analysis, applications to geometry, electromagnetic theory, Lagrangian and Hamiltonian formulations of mechanics; other topics of interest.

**MATH 551-552 Introduction to General Topology I-II.** (3-3 Hours) Prerequisites: Mathematics 223 and approval of department. Elementary set theory, ordinals and cardinals; topological spaces; cartesian products; connectedness; special topologies; separation axioms; covering axioms, metric spaces; convergence; compactness; function spaces; spaces of continuous functions and complete spaces; homotopy; maps into spheres; topology of  $E_n$ ; homotopy type; introduction to algebraic topological ideas.

**MATH 553-554 Introductory Algebraic Topology I-II.** (3-3 Hours) Prerequisites: Mathematics 552 and approval of department. Complexes, simplicial, singular and Čech Homology Theory. Homotopy groups and basic theorems of algebraic topology.

**MATH 555-556 Introduction to Combinatorial Topology I-II.** (3-3 Hours) Prerequisites: Mathematics 553 and approval of department. Properties of topological spaces; Jordan's theorem, surfaces, complexes, coverings, dimension; the Betti Groups, homology theory, manifolds, the duality theorems, cohomology groups of compacta, introduction to theory of continuous mappings of polyhedra.

**MATH 557-558 Introduction to Algebraic Geometry I-II.** (3-3 Hours) Prerequisites: Mathematics 512, 521, or approval of the department. Algebraic preliminaries, local rings valuation theory, power series, rings, geometry of algebraic varieties with emphasis on curves and surfaces.

**MATH 559-560 Linear Programming I-II.** (3-3 Hours) Basic Concepts, graph theory, theory of games, Markov Chains, Leontief Economic Models, Optimizing linear functions of variables subject to constraints, a geometric approach, simplex method, convex sets duality, applications.

**MATH 561-562 Probability and Statistics I-II.** (3-3 Hours) Prerequisite: Mathematics 532 or approval of department. Basic concepts of measure theory and integration axiomatic foundations of probability theory, distribution functions and characteristics functions, central limit problem, modern statistical inference, analysis, variance, decision functions.

**MATH 563-573 Design I-II.** (3-3 Hours) Prerequisite: Mathematics 272. Experimental Design: Completely randomized design; randomized block designs, factorial experiments split plot design, confounding.

**MATH 564 Linear Models.** (3 Hours) Prerequisite: Mathematics 562 or departmental approval. Linear statistical models, some noise-reducing experimental designs, an example-of a volume-increasing design, fitting the general linear model, inference making, multi parameter hypothesis: the analysis of variance, the effect of coding on the analysis, seeking a maximum or minimum response, fractional factorial experiments and incomplete block designs, an example of a completely random model, mixed models.

**MATH 565 Multivariate Analysis.** (3 Hours) Prerequisites: Mathematics 562 and approval of department. General linear hypothesis; least square estimation; confidence regions, multiple comparison; analysis of complete layouts; effects of departures from underlying assumptions. Analysis of covariance.

**MATH 566-566W Operations Research.** (3-3 Hours) Prerequisite: Math 232, 355. Linear programming, network analysis, PERT-CPM, dynamic programming, queuing theory and decision analysis.

**MATH 567-568 Nonparametric Statistics I-II.** (3-3 Hours) Prerequisites: Mathematics 562 and approval of department. Problems of estimating testing

hypotheses when the functional form of the underlying distribution is unknown. Robust methods; sign test, rank test and confidence procedures based on these tests; tests based on permutations of observations. Non-parametric tolerance limits; large sample properties of the tests, multi sample problems; ranking methods in analysis of variance; Bivariate and multivariate procedures, efficiency comparisons.

**MATH 569-570 Functions of Several Real Variables I-II.** (3-3 Hours) Prerequisites: Mathematics 533 and approval of department. Euclidean spaces, Mapping and differentials, manifolds, differential forms, vector analysis.

**MATH 571-572 Numerical Analysis I-II.** (3-3 Hours) Prerequisite: Approval of department. Introduction to Matlab, approximate differentiation, local truncation error and order, Euler's method, Runge-Kutta methods, embedded Runge-Kutta methods, stiff equations and implicit methods, explicit multi-step methods, implicit multi-step methods, shooting method, finite element method, finite difference methods for partial differential equations.

**MATH 573 Fractal Geometry.** (3 Hours) Prerequisite: Math 511 or departmental approval. Metric spaces, equivalent spaces, classification of subsets, and the Space of Fractals. Transformations on metric spaces, contraction mappings, and the Construction of Fractals. Chaotic Dynamics of Fractals, Fractal Dimension. Fractal Interpolation. Julia Sets. Parameter Spaces and Mandelbort Sets. Measures on Fractals.

**MATH 574 Numerical Linear Algebra.** (3 Hours) Prerequisite: Approval of department. Elementary numerical analysis; matrix algebra; elimination and compact elimination methods; orthogonalization methods; condition, accuracy, and precision; comparison of methods; iterative and gradient methods; iterative and transformation methods for latent roots and vectors; error analysis for latent roots and vectors.

**MATH 575-576 Approximation and Interpolation I-II.** (3-3 Hours) Prerequisite: Approval of department. Interpolation, remainder theory; convergence theorems; infinite interpolation; uniform approximation; best approximation; least squares approximation; Hilbert space; orthogonal polynomials; closure and completeness.

**MATH 577-578 Ordinary Differential Equation I-II.** (3-3 Hours) Ordinary differential equations: basic theorems of existence, uniqueness, and continuous dependence of the solutions; linear differential equations and systems; stability theory; topology of integral curves; differential equations in the complex domain, asymptotic integration; boundary value problems. Partial differential equations; equations of first order method of characteristics, Hamilton-Jacobi theory; equations of second order-classification according to type; elliptic equations-potential equation, maximum principle, characteristics, and other topics of interest.

**MATH 579-580 Partial Differential Equations I-II.** (3-3 Hours) Prerequisite: Mathematics 577 or

departmental approval. Linear equations with constant coefficients in two independent variables, applications, eigenfunction expansions, homogeneous and nonhomogeneous equations. Fourier series, existence, solution uniqueness and representation, Initial boundary value problems, Laplace's equation, and special topics.

**MATH 581-582 Number Theory I-II.** (3-3 Hours) Prerequisites: Approval of department. Diophantine analysis, primes, residue classes, theorems of Euler, Fermat, and Wilson, Continued Fractions, Chinese Remainder Theorem, quadratic reciprocity, valuations, extensions of valuations, local and global fields, discriminant.

**MATH 583 Advanced Number Theory.** (3 Hours) Prerequisite: Mathematics 581 or departmental approval. Quadratic and Cyclotomic extensions, elementary class field theory, and selected topics.

**MATH 584 Independent Study.** (3 Hours) Prerequisite: Departmental consent. Intensive study and research of a subject selected in accordance with student needs and arranged in consultation with the staff. Topics will vary. Student will make periodic reports on his/her reading and will prepare a scholarly paper on a problem.

**MATH 585-586 Introductory Algebraic Number Theory I-II.** (3-3 Hours) Prerequisites: Mathematics 512, 582, and approval of department. Valuations, fields of algebraic functions, cohomology of groups, local and global class field theory are introduced as topics.

**MATH 586A Special Projects: Mathematics Curriculum Planning.** (3 Hours) Prerequisite: Departmental consent. This course is designed primarily for inservice personnel in education desiring enrichment activities in mathematics curriculum planning K-12. Students taking this course will be engaged in activities directed toward planning, developing, and evaluating curricular materials that may be used for teaching grades K-12.

**MATH 587 Introductory Analytic Number Theory.** (3 Hours) Elements from prime number theory, prime number theory for arithmetic progressions, additive number theory density theorems.

**MATH 588-589 Sampling Methods I-II.** (3-3 Hours) Prerequisite: Mathematics 272. Sampling methods: Simple random sampling, sampling for proportions and percentages, estimation of sample size, stratified random sampling ratio estimates.

**MATH 590 Thesis.** (3 Hours) The candidate for the Master of Science in Teaching degree must present a Thesis embodying the results of his research. The candidate chooses his problem, but approval by his adviser is required.

**MATH 591-592 Modern Logic I-II.** (3-3 Hours) Prerequisite: Approval of department. Elementary introduction to classical first order theory (completeness, deduction theorem, Godel completeness, Herbrand's Theorem), presentation of basic model theory; axiomatic set theory, cardinal and ordinal numbers to the consistency results of Godel

and the independence results of Cohen, Incompleteness Results (Godel's, Rossi's and Church's Theorem).

**MATH 593 Theory of Models.** (3 Hours) Prerequisites: Mathematics 592 and approval of department. Infinitary languages, ultraproducts, compactness, saturated structures, applications to mathematical theories; other topics as time permits.

**MATH 594 Decidability and Undecidability.** (3 Hours) Prerequisites: Mathematics 592 and approval of department. Godel's incompleteness theorem for arithmetic, recursive nonaxiomatizability of second-order logic, Church's Undecidability Theorem for first-order logic, decidable first-order theories; other topics as time permits.

**MATH 595-596 Foundations of Set Theory I-II.** (3-3 Hours) Prerequisite: Mathematics 591 or approval of department. Axiom systems, ordinal and cardinal arithmetic, model theory of set theory, constructible sets, relative consistency and independence of Axiom and Choice and generalized continuum hypothesis.

**MATH 597-598 Theory of Recursive Functions I-II.** (3-3 Hours) Prerequisites: Mathematics 592 and approval of department. Turing machines, recursive functions, recursive and recursively enumerable sets, Post's Problem and degrees of insolubility, recursion theorem, lattice of r.e. sets, hierarchies.

**MATH 599 Thesis.** (3 Hours) The candidate for the Master's degree must present a Thesis embodying the results of his research. The candidate chooses his problem, but approval by his adviser is required.

**MATH 600 Research.** (3 Hours) Prerequisite: Department approval. Mathematics research.

**MATH 611-612 Algebra I-II.** (3-3 Hours) Prerequisite: Approval of department. Groups and operator groups; basic constructions; isomorphism theorems; Jordan-Holder theorem. Rings and ideals, polynomial rings and group rings; integral domains, factorization theory. Modules and vector spaces, linear mappings; theory of fields and field extensions; normal extensions; separability, Galois theory, finite fields, algebraic closure. Advanced topics.

**MATH 613-614 Homological Algebra I-II.** (3-3 Hours) Prerequisites: Mathematics 512 and approval of department. Categories, functors, spectral sequences, cohomology of groups. Abstract category theory.

**MATH 615-616 Finite Groups I-II.** (3-3 Hours) Prerequisites: Mathematics 512 and approval of department. Permutation representations. Sylow's theorems, commutator calculus, nilpotent groups; pgroups. Finiteness conditions; Burnside problem. Solvable groups; theorems of Hall and Cunihin. Special topics.

**MATH 617-618 Ring Theory I-II.** (3-3 Hours) Prerequisite: Mathematics 511 or departmental approval. Definition and examples of rings, some special classes of rings, homomorphisms, ideals and quotient rings, more ideals and quotient rings. The field of quotients and integral domains, Euclidean Rings, polynomial rings, polynomials over the rational

field, polynomial rings over commutative rings, localization, principal rings, and selected topics.

**MATH 619-620 Universal Algebra I-II.** (3-3 Hours) Prerequisites: Mathematics 512 and approval of department. Basic definitions. Subalgebras, congruences and homomorphisms. Direct products, lattices, Boolean algebras, Stone's representation theorem; varieties of algebras, free algebras; special topics.

**MATH 621-622 Advanced Modern Geometry I-II.** (3-3 Hours) Prerequisite: Approval of department. Geometries and their properties. Emphasis on properties and comparisons with systems. Analytic and synthetic projective geometry; structural systems. Advanced topics.

**MATH 623-624 Differential Geometry I-II.** (3-3 Hours) Survey of minimal surfaces, submanifolds, plateau's problem, Bernstein's problem; complex manifolds, Kahler metric. The Chern class. Albanese and Picard varieties. Holomorphic vector fields, automorphism group. Hodge manifolds.

**MATH 625-626 Algebraic Geometry I-II.** (3-3 Hours) A study in the plane, based on homogeneous point and line coordinates; a study of algebraic curves and envelopes, including such topics as invariants, singularities, reducibility, genus polar properties, Pascal and Brianchon theorems, and Jacobian, Hessian and Plucker Formulas.

**MATH 629-630 Theory of Fields I-II.** (3-3 Hours) Prerequisites: Mathematics 511, 512 or departmental approval. Extension fields, the transcendence of  $e$ , roots of polynomials, construction with straight-edge and compass, Galois Theory, solvability by radicals, real fields, absolute values, applications, selected topics.

**MATH 631-632 Real Variables I-II.** (3-3 Hours) Prerequisite: Mathematics 532 or approval of department. The Lebesgue integral, Function Spaces and Banach Spaces, Differentiation, integration of Product Spaces, Lebesgue Stieltjes Integral, linear functionals, implicit and inverse function theorems, Fubini's Theorem, Stokes' Theorem  $L_p$  classes; applications to Fourier Series.

**MATH 633-634 Functional Analysis I-II.** (3-3 Hours) Prerequisite: Mathematics 541 or departmental approval. Advanced Topics. Fundamentals of the theory of vector spaces, Banach Spaces; Functional equations; applications to fields of analysis. Non-linear problems. Schauder-Leray fixed-point theorem and its applications to fundamental existence theorems of analysis, convex sets and weak topologies, operators and their adjoints, seminorms. Orthogonal projection and Liesz's Representation Theorem, the Hahn-Banach Theorems, normed ring, Ergodic and diffusion theory.

**MATH 635-636 Advanced Ordinary Differential Equations I-II** (3-3 Hours) Prerequisite: Mathematics 541. Approval of department. Existence theorem; linear systems; regular and irregular singular points; special topics.

**MATH 637-638 Advanced Partial Differential Equations I-II.** (3-3 Hours) Prerequisite: Mathematics 541. Approval of department. Classical theory of partial differential equations, together with an introduction to the modern theory based on functional analysis.

**MATH 639-640 Theory of Integration I-II. (3-3 Hours)** Prerequisite: Mathematics 632 or approval of department. Differentiation and integration, classical Banach spaces, abstract spaces, compact spaces, Banach spaces, measure and integration, measure and outer measure, the Daniell Integral, measure and topology, mappings and measurable spaces.

**MATH 641-642 Complex Variables I-II.** (3-3 Hours) Prerequisite: Approval of department. The plane and sphere of complex numbers, Differentiability and Cauchy- Riemann differential equations; Cauchy's integral theorem and integral formula. Series of analytic functions. Expansion in power series. Laurent expansion. Singularities, residue theorem, conformal mapping, Riemann mapping theorem, complex manifolds. Reflection principles, theorem of Mittag-Leffler product theorem of Weierstrass theorems of Runge and Poincare. Poisson's Integral Formula, other topics of interest.

**MATH 643-644 Functions of Several Complex Variables I-II.** (3-3 Hours) Prerequisites: Mathematics 642 and approval of department. Definition of homomorphic and meromorphic functions. Sequences of holomorphic functions. Analytic sets. Theorems of Cousin I, II, and Poincare. Kneser-Weierstrass integral. Functions of finite order, Jacobian Functions, Analytical continuation. Singularities of function and analytic sets on analytic sets. Integral representations of holomorphic functions. Envelopes of holomorphy. Complex manifolds and complex spaces; special topics.

**MATH 645-646 Several Complex Variables III.** (3-3 Hours) Prerequisites: Mathematics 644 and approval of department. Elementary properties of holomorphic functions. Local theory of homomorphic functions and analytic sets. Analytic continuation. Coherent analytic sheaves. Cohomology with coefficients in sheaves. Stein spaces. Theorems A and B of Cartan. Theorems of Poincare and Cousin. Embedding theorems. Theorem of Runge. Envelopes of holomorphy, Levi's problem. Holomorphic maps. Compact complex spaces.

**MATH 647 Entire Functions.** (3 Hours) Prerequisites: Mathematics 642 and approval of department. First and Second Main Theorem of Nevanlinna. Functions of finite order. Hadamard's Theorem, functions of the exponential type. Functions of regular growth. Functions in the unit disk, Blasche Product. First and Second Main Theorem of Nevanlinna for functions for several variables, special topics.

**MATH 649-650 Several Real Variables I-II.** (3-3 Hours) Prerequisite: Mathematics 641 or approval of department. Necessary and sufficient conditions for an extremum, variations of Hamilton's Principle, the nonparametric problem of Bolza, parametric

problems, direct methods, measure, integrals and derivatives, Lebesgue Integrals, Hamilton-Jacobi Theory, applications, nonclassical problems, selected topics.

**MATH 651-652 General Topology I-II.** (3-3 Hours) Prerequisite: Approval of department. Fundamentals of set theory, topological spaces, metric spaces, Function spaces and separation axioms. Complexes, homotopy and basic theorems in algebraic topology.

**MATH 653-654 Algebraic Topology I-II.** (3-3 Hours) Prerequisite: Mathematics 652 or 554. Approval of department. Fibre spaces, extension problems, obstruction theory.

**MATH 655-656 Combinatorial Topology I-II.** (3-3 Hours) Prerequisite: Mathematics 553 or departmental approval. Advanced properties of topological spaces, homology theory, cohomology groups of compacta, selected topics.

**MATH 657-658 Differential Topology I-II.** (3-3 Hours) Prerequisites: Mathematics 652 and 525 or 623. Study of differential manifolds from a viewpoint approximately midway between topology and differential geometry. Embedding manifolds in Euclidean spaces, transverse regularity of mappings, vector space bundles, universal bundles, characteristic classes, and the Thom Theory of Cobordism. Morse Theory of non-degenerate functions on a manifold, Morse Theory of geodesics, spherical modifications, theory of differentiable homotopy spheres, theory of handlebodies.

**MATH 659-660 Algebraic Topology III-IV.** (3-3 Hours) Prerequisite: Mathematics 654 or departmental approval. Sheaves and extraordinary cohomology theories, selected topics.

**MATH 668 Topics in Statistics.** (3 Hours) Prerequisite: Mathematics 562 or departmental approval. Topics in the advanced theory of statistics.

**MATH 671-672 Advanced Numerical Analysis III.** (3-3 Hours) Prerequisite: Mathematics 572 or departmental approval. Selected topics in advanced numerical analysis.

**MATH 673-674 Approximation and Interpolation I-II.** (3-3 Hours) Prerequisite: Mathematics 576 or departmental approval. Expansion theorems, degree of approximation of linear functions, selected topics.

**MATH 677-678 Advanced Set Theory I-II.** (3-3 Hours) Prerequisite: Mathematics 596 or departmental approval. Many equivalencies of the Axiom of Choice, selected topics.

**MATH 681-682 Infinite Series I-II.** (3-3 Hours) Prerequisite: Mathematics 540 or departmental approval. Selected topics are covered.

**MATH 683-684 Theory of Summability I-II.** (3-3 Hours) Prerequisite: Mathematics 539 or departmental approval. Advanced summability theory of series such as the Karamata-Lototsky-Jakimovski types, selected topics.

**MATH 687-688-689 Research I-II-III.** (3-3-3 Hours) Research in Mathematics.

**MATH 690 Topics in Mathematics Education.** (3 Hours) Prerequisite: Departmental approval. Selected topics are covered.

**MATH 691 Topics in Algebra.** (3 Hours)

Prerequisite: Departmental approval.

**MATH 692 Topics in Geometry.** (3 Hours)

Prerequisite: Departmental approval.

**MATH 693 Topics in Real Analysis.** (3 Hours)

Prerequisite: Departmental approval.

**MATH 694 Topics in Complex Analysis.** (3 Hours)

Prerequisite: Departmental approval.

**MATH 695 Topics in Probability and Statistics.** (3

Hours) Prerequisite: Departmental approval.

**MATH 696 Topics in Number Theory.** (3 Hours)

Prerequisite: Departmental approval.

**MATH 697 Topics in Numerical Analysis.** (3

Hours) Prerequisite: Departmental approval.

**MATH 698 Topics in Logic and Foundations.** (3

Hours) Prerequisite: Departmental approval.

**MATH 699 Dissertation.** (3 Hours) Prerequisite:

Departmental approval. Research in Mathematics.

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**DEPARTMENT OF PHYSICS,  
ATMOSPHERIC SCIENCES AND  
GEOSCIENCE**

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**Faculty**

Dr. M. Fadavi, Professor

Dr. E. Heydari, Associate Professor

The Department of Physics, Atmospheric Sciences and Geoscience has the major teacher training responsibility in the School of Science and Technology. This program leads to the (MST) degree in Science Education with a concentration in one of the following areas: (Astronomy, Biology, Chemistry, General Science, Physics and Physical Science). The Department also offers for credit graduate science education and science content courses for graduate students of other programs. Several courses are offered for inservice teachers and other educators for professional development. These courses are often used toward certification and further degrees.

**Accreditation**

This program is accredited by the National Council for Accreditation of Teacher Education (NCATE).

**Program Objectives**

1. To provide additional preparation for science teachers and science supervisors in scientific content and supervision techniques.
2. To enable teachers of science to gain insight into the kinds of science experiences that are relevant to the needs of today's youth.
3. To develop in science teachers an awareness of the modern trends and problems in science teaching.
4. To enrich current and potential science teachers and educators with content and pedagogy in science and science education areas.
5. To offer courses of use to different non-departmental graduate degree programs.

**Admission Requirements**

Hold a baccalaureate degree with a major or minor in one of the natural sciences from an accredited college or university. Student maybe admitted conditionally if the Graduate Record Examination (GRE) is not taken.