

MASTER OF SCIENCE IN MATHEMATICS

Candidates for the degree of Master of Science in Mathematics must complete thirty (30) credits of approved 400-level courses offered by the Department of Mathematics and Computer Science numbered 400 or above, with a minimum of six (6) credits completed in 500-level courses.

A thesis option is available whereby a candidate can write and defend a written thesis under the direction of a faculty advisor. At most, six of the required thirty credits may be earned through thesis work. Students electing a thesis option should consult the department chairperson for details regarding thesis-preparation guidelines.

CS. COMPUTER SCIENCE

CS-419. PRINCIPLES OF PROGRAMMING LANGUAGES Credits: 3

A study of the principles that govern the design and implementation of programming languages. Topics include language structure, data types, and control structures. Programming projects will familiarize students with the features of programming languages through their implementation in interpreters.

Pre-Requisites

CS-226 or equivalent

CS-421. SIMULATION AND DATA ANALYSIS Credits: 3

Methods of handling large databases including statistical analysis and computer simulations. The emphasis will be upon discrete simulation models with a discussion of relevant computer languages, SLAM, GPSS, and/or SIMSCRIPT.

Pre-Requisites

CS-125 (or the equivalent programming experience) and one semester of calculus.

CS-423. THEORY OF COMPUTATION Credits: 3

This course formalizes many topics encountered in previous computing courses. Topics include: languages, grammars, finite automata, regular expressions and grammars, context-free languages, push-down automata, Turing machines and computability.

Pre-Requisites

MTH-232 (Discrete Mathematics II) and CS-126 (or the equivalent programming experience).

CS-424. SYSTEMS ANALYSIS Credits: 3

A study of the design and implementation of large computer projects. Special emphasis is placed on applications to business systems. Students will use a CASE tool for automated systems analysis and design.

Pre-Requisites

CS-226 or equivalent

CS-425. DATABASE MANAGEMENT

Credits: 3

Practical experience in solving a large-scale computer problem including determination of data requirements, appropriate data organization, data manipulation procedures, implementation, testing and documentation.

Pre-Requisites

CS-126 or permission of the instructor.

CS-426. OPERATING SYSTEM PRINCIPLES Credits: 3

Analysis of the computer operating systems including Batch, Timesharing, and Realtime systems. Topics include sequential and concurrent processes, processor and storage management, resource protection, processor multiplexing, and handling of interrupts from peripheral devices.

Pre-Requisites

CS-226 or equivalent

CS-427. COMPILER DESIGN Credits: 3

A study of compiler design including language definition, syntactic analysis, lexical analysis, storage allocation, error detection and recovery, code generation and optimization problems.

Pre-Requisites

CS-226 or equivalent

CS-428. ALGORITHMS Credits: 3

Theoretical analysis of various algorithms. Topics are chosen from sorting, searching, selection, matrix multiplication and multiplication of real numbers, and various combinational algorithms.

Pre-Requisites

CS-226 or equivalent and MTH-232 (Discrete Mathematics II).

CS-430. COMPUTER ARCHITECTURE Credits: 3

A study of the design, organization, and structure of computers, ranging from the microprocessors to the latest 'supercomputers.'

Pre-Requisites

CS-226 or equivalent

CS-434. SOFTWARE ENGINEERING Credits: 3

A course in 'programming in the large.' Topics include software design, implementation, validation, maintenance and documentation. There will be one or more team projects. Prerequisite CS-226 or equivalent

CS-435. ADVANCED DATABASE CONCEPTS Credits: 3

Practical experience involving unstructured data collections. Topics cover big data, data mining, predictive modeling, decision analysis, and indexing and retrieval including probabilistic, clustering, thesauri, and passage based retrieval strategies.

Pre-Requisites

CS-325 (Database Management) or CS340 Artificial Intelligence

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CS-440. ARTIFICIAL INTELLIGENCE

Credits: 3

This course will provide an overview of artificial intelligence (AI) application areas and hands-on experience with some common AI computational tools. Topics include search, natural language processing, theorem proving, planning, machine learning, robotics, vision, knowledge-based systems (expert systems), and neural networks.

Pre-Requisites

[CS-126](#) (Unix) and equivalent programming experience in a high-level language.

CS-450. OBJECT-ORIENTED PROGRAMMING

Credits: 3

Object-oriented concepts and their application to human-computer interaction. Concepts to be covered include objects, classes, inheritance, polymorphism, design patterns, GUI interface guidelines and design of interfaces. There will be programming projects in object-oriented languages.

Pre-Requisites

[CS-226](#) or equivalent

CS-455. COMPUTER NETWORKS

Credits: 3

This course introduces basic concepts, architecture, and widely used protocols of computer networks. Topics include the Open System Interconnection (OSI) model consisting of physical link layer, data layer, network layer, transport layer, session layer, presentation layer, and application layer, medium access sublayer and LAN; various routing protocols; Transmission Control Protocol (TCP) and Internet Protocol (IP) for internetworking.

Pre-Requisites

Either [CS-225](#) and [CS-246](#)

CS-463. OPERATIONS RESEARCH

Credits: 3

A survey of operations research topics such as decision analysis, inventory models, queueing models, dynamic programming, network models, and linear programming. (Cross-listed with [MTH-463](#))

Pre-Requisites

Programming experience in a high-level language and completion of one semester of calculus.

CS-464. NUMERICAL ANALYSIS

Credits: 3

An introduction to numerical algorithms as tools to providing solutions to common problems formulated in mathematics, science, and engineering. Focus is given to developing the basic understanding of the construction of numerical algorithms, their applicability, and their limitations. (Cross-listed with [MTH-464](#))

Pre-Requisites

Programming experience in a high-level language and completion of a one-year calculus sequence.

CS-467. COMPUTER GRAPHICS

Credits: 3

Introduction to equipment and techniques used to generate graphical representations by computer. Discussion of the mathematical techniques necessary to draw objects in two and three-dimensional space. Emphasis on application programming and the use of a high-resolution color raster display.

Pre-Requisites

[CS-226](#) or equivalent

CS-483. WEB DEVELOPMENT

Credits: 3

An introduction to the development of dynamic, database-driven sites, including active server pages, PHP, authentication, session tracking and security, and the development of shopping cart and portal systems.

Pre-Requisites

[CS-283](#) (Web Development I) and [CS-325](#) (Database Management).

CS-498. TOPICS IN COMPUTER SCIENCE

Credits: variable

Variable credit study of one or more special topics in computer science. May be repeated for credit provided a different topic is selected.

MTH. MATHEMATICS

MTH-411. REAL ANALYSIS

Credits: 4

A rigorous treatment of fundamental concepts in analysis, with emphasis on careful reasoning and proofs. Topics covered include the completeness and order properties of real numbers; limits and continuity; conditions for integrability and differentiability; infinite sequences and series of functions. Basic notions of the topology of the real line are also introduced.

Pre-Requisites

[MTH-302](#) (Introduction to Higher Mathematics) or consent of instructor

MTH-413. FUNCTIONS OF SEVERAL VARIABLES

Credits: 3

A modern treatment of calculus of functions of several real variables. Topics include: Euclidean spaces, differentiation, integration and manifolds leading to the classical theorems of Green and Stokes.

Pre-Requisites

[MTH-214](#) (Linear Algebra) and [MTH-411](#) (Real Analysis) or consent of instructor.

MTH-414. COMPLEX ANALYSIS

Credits: 3

Complex functions, limit, continuity, analytic functions, power series, contour integration, Laurent expansion, singularities and residues.

Pre-Requisites

[MTH-212](#) (Multivariable Calculus) or consent of instructor.

MTH-431. ABSTRACT ALGEBRA I**Credits:** 4

A rigorous treatment of fundamental concepts in algebra, with emphasis on careful reasoning and proofs. Topics covered include equivalence relations, binary operations. Integers: divisibility, factorization, integers modulo n , elementary group theory, subgroups, cyclic groups, permutation groups, quotient groups. Homomorphisms and isomorphisms. Introductory topics in ring theory as time permits.

Pre-Requisites

[MTH-302](#) (Introduction to Higher Mathematics) or consent of instructor

MTH-432. ABSTRACT ALGEBRA II**Credits:** 3

A continuation of [MTH-431](#). Includes the study of polynomial rings, ideals, field extensions and Galois Theory.

Pre-Requisites

[MTH-431](#) (Abstract Algebra).

MTH-442. TOPOLOGY**Credits:** 3

An introduction to point-set topology, including a study of metric spaces, topological spaces, countability and separation axioms, compactness, connectedness, product spaces.

Pre-Requisites

[MTH-411](#) (Real Analysis) or consent of instructor.

MTH-443. GEOMETRY**Credits:** 3

A study of selected topics from Euclidean and non-Euclidean geometry.

Pre-Requisites

[MTH-302](#) (Introduction to Higher Mathematics) or consent of instructor

MTH-451. PROBABILITY AND MATHEMATICAL STATISTICS I**Credits:** 3

Random variables, probability distributions, expectation and limit theorems, confidence intervals.

Pre-Requisites

A one-year calculus sequence or consent of instructor.

MTH-452. PROBABILITY AND MATHEMATICAL STATISTICS II**Credits:** 3

Hypothesis testing, non-parametric methods, multivariate distributions, introduction to linear models.

Pre-Requisites

[MTH-451](#) or consent of instructor.

MTH-454. STATISTICAL METHODOLOGY**Credits:** 3

This course emphasizes applications, using statistical computer packages (R, SPSS) and real data sets from a variety of fields. Topics include estimation and testing; stepwise regression; analysis of variance and covariance; design of experiments; contingency tables; and multivariate techniques, including logistic regression.

Pre-Requisites

[MTH-451](#) or consent of instructor.

MTH-461. PARTIAL DIFFERENTIAL EQUATIONS**Credits:** 3**Fees:** \$40

Partial differential equations and boundary value problems, inner product spaces, orthogonal functions, eigen value problems, Sturm-Liouville equations, Fourier series, Fourier transforms, Green's functions, and classical equations of engineering and physics.

Offered fall of odd years.

Pre-Requisites

[MTH-211](#) and [MTH-212](#)

MTH-462. ADVANCED CALCULUS**Credits:** 3**Fees:** \$40

Topics from advanced calculus, including matrix representation of differentials and the multivariable chain rule, vector calculus, curvilinear coordinates, tensors, change of variables in higher dimensions, improper multiple integrals, applications of line and surface integrals, differential forms and the general Stokes' theorem, potential theory, and Taylor's formula for functions of several variables.

Offered fall of even years

Pre-Requisites

[MTH-212](#) (Multivariable Calculus)

MTH-463. OPERATIONS RESEARCH**Credits:** 3

A survey of operations research topics such as decision analysis, inventory models, queuing models, dynamic programming, network models, and linear programming. Cross-listed with [CS-463](#). Offered in the spring semester of odd-numbered years when demand warrants.

Pre-Requisites

Programming experience in a high-level language and completion of a one-year calculus sequence.

MTH-464. NUMERICAL ANALYSIS**Credits:** 3

An introduction to numerical algorithms as tools to providing solutions to common problems formulated in mathematics, science, and engineering. Focus is given to developing the basic understanding of the construction of numerical algorithms, their applicability, and their limitations. (Cross-listed with [CS-464](#))

Pre-Requisites

Programming experience in a high-level language and completion of a one-year calculus sequence.

MTH-465. NUMERICAL LINEAR ALGEBRA**Credits:** 3

Direct and iterative methods for the solution of systems of linear equations, matrix decompositions, computation of eigenvalues and eigenvectors, and relaxation techniques. The theoretical basis for error analysis including vector and matrix norms. Applications such as least squares and finite difference methods. Offered spring semester of even-numbered years.

Pre-Requisites

[MTH 214](#) and [CS 125](#) (or equivalent programming experience)

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MTH-470. READINGS IN MATHEMATICS

Credits: 3

Pre-Requisites

Consent of Mathematics Department Chairperson May be repeated for credit if a different topic is selected.

MTH-511. MEASURE AND INTEGRATION

Credits: 3

Measures, measurable functions, integration, convergence theorems, product measures, signed measures.

Pre-Requisites

[MTH-442](#) or consent of instructor.

MTH-513. FUNCTIONAL ANALYSIS

Credits: 3

Topics include: Banach spaces, L_p-spaces, Hilbert spaces, topological vector spaces, and Banach algebra.

Pre-Requisites

[MTH-411](#) and a course in linear algebra.

MTH-532. MODERN ALGEBRA

Credits: 3

A study of group theory (including the Sylow Theorems and solvable groups); ring theory (including the Noetherian rings and UFDs); modules, tensor algebra, and semi-simple rings.

Pre-Requisites

[MTH-431](#), and a course in linear algebra or consent of instructor.

MTH-542. ALGEBRAIC TOPOLOGY

Credits: 3

Polyhedra, simplicial homology theory, cohomology rings, and homotopy groups.

Pre-Requisites

[MTH-442](#).

MTH-590. THESIS WRITING

Credits: up-6

Pre-Requisites

Consent of Department Chairperson