

MATH Mathematics

MATH 0997 Support for Quantitative Reasoning

2 Credit Hours. 2 Lecture Hours. 0 Lab Hours.

This Learning Support course provides corequisite support in mathematics for students enrolled in MATH 1001 – Quantitative Reasoning. Topics will parallel topics being studied in MATH 1001 and the course will provide support for the essential quantitative skills needed to be successful in MATH 1001. Taken with MATH 1001, topics to be covered will include logic, basic probability, data analysis and modeling from data.

Corequisite(s): MATH 1001.

MATH 0998 Support for Mathematical Modeling

2 Credit Hours. 0 Lecture Hours. 2 Lab Hours.

This Learning Support course provides corequisite support in mathematics for students enrolled in MATH 1101 – Introduction to Mathematical Modeling. Topics will parallel topics being studied in MATH 1101 and the course will provide support for essential quantitative skills needed to be successful in MATH 1101. Taken with MATH 1101, this course is an introduction to mathematical modeling using graphical, numerical, symbolic, and verbal techniques to describe and explore real-world data and phenomena. Emphasis is on the use of elementary functions to investigate and analyze applied problems and questions, supported by the use of appropriate technology, and on effective communication of quantitative concepts and results.

Corequisite(s): MATH 1101.

MATH 0999 Support for College Algebra

2 Credit Hours. 2 Lecture Hours. 0 Lab Hours.

This Learning Support course provides corequisite support in mathematics for students enrolled in MATH 1111 – College Algebra. Topics will parallel topics being studied in MATH 1111 and the course will provide support for the essential quantitative skills needed to be successful in MATH 1111. Taken with MATH 1111, this course provides an in-depth study of the properties of algebraic, exponential and logarithmic functions as needed for calculus. Emphasis is on using algebraic and graphical techniques for solving problems involving linear, quadratic, piece-wise defined, rational, polynomial, exponential and logarithmic functions.

Corequisite(s): MATH 1111.

MATH 1001 Quantitative Reasoning

3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.

Catalog Description: Emphasis on processing information via models by conducting assumption validity, applicability and suitability checks, executing appropriate calculations to do forecasts and arrive at logical decisions. Will rely on examples to illustrate use of mathematics in real world situations. This course is an alternative in Area A of the Core Curriculum and is not intended to supply sufficient algebraic background for students who intend to take precalculus or the calculus sequences for mathematics and science majors.

Prerequisite(s): A minimum grade of "C" in in MATH 0099 or MATH 0997.

MATH 1001M Quant Skill & Reasoning by WC

3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.

MATH 1101 Introduction to Mathematical Modeling

3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.

Mathematical modeling using graphical, numerical, symbolic, and verbal techniques to describe and explore real-world data and phenomena. The investigation and analysis of applied problems and questions, and effective communication of quantitative concepts and results. Topics include linear, quadratic, polynomial, exponential and logarithmic models of real-world phenomena. Credit cannot be earned toward graduation for MATH 1111 if credit is earned for MATH 1101.

Prerequisite(s): Two years of high school algebra or equivalent.

MATH 1111 College Algebra

3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.

This course provides an in-depth study of the properties of algebraic, exponential and logarithmic functions as needed for calculus. Emphasis is on using algebraic and graphical techniques for solving problems involving linear, quadratic, piecewise defined, rational, polynomial, exponential, and logarithmic functions. Credit cannot be earned toward graduation for MATH 1101 if credit is earned for MATH 1111.

Prerequisite(s): Two years of high school algebra or equivalent.

MATH 1112 College Trigonometry

3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.

This course is an in-depth study of the properties of trigonometric functions and their inverses. Topics include circular functions, special angles, solutions of triangles, trigonometric identities and equations, graphs of trigonometric functions, inverse trigonometric functions and their graphs, Law of Sines, Law of Cosines, and vectors. Credit may not be received for both MATH 1112 and MATH 1113.

Prerequisite(s): A minimum grade of "C" in MATH 1111.

MATH 1113 Pre-Calculus Mathematics

3,4 Credit Hours. 3,4 Lecture Hours. 0 Lab Hours.

This course is an intensive study of the basic functions needed for the study of calculus. Topics include algebraic, functional, and graphical techniques for solving problems with algebraic, exponential, logarithmic, and trigonometric functions and their inverses. Credit cannot be earned toward graduation for MATH 1112 if credit is earned for MATH 1113.

Prerequisite(s): MATH 1111 with a minimum grade of "C".

MATH 1113M Pre-Calculus Math by WC

4 Credit Hours. 4 Lecture Hours. 0 Lab Hours.

Designed to prepare students for calculus, physics, and related technical subjects. Topics include an intensive study of algebraic, trigonometric, logarithmic, and exponential functions accompanied by analytical geometry.

MATH 1232 Survey of Calculus

3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.

Covers the fundamental elements of differential and integral calculus of algebraic, logarithmic and exponential functions. Topics include a brief review of algebraic principles, limits, derivatives and integrals. Appropriate technology will be incorporated throughout the course.

Prerequisite(s): A minimum grade of "C" in MATH 1101 or MATH 1111 or MATH 1113 or MATH 1112.

MATH 1401 Intro to Statistics

3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.

The course is a course in basic statistics. Topics include descriptive statistics, probability, distributions, hypothesis testing, inferences, correlation, and regression.

Prerequisite(s): STAT 2231 and a minimum grade of "C" in MATH 1101 or MATH 1111.

MATH 1441 Calculus I

4 Credit Hours. 0,4 Lecture Hours. 0,1 Lab Hours.

Functions and limits; the derivative and its applications, antidifferentiation; the definite integral and applications; exponential and logarithmic functions. **Prerequisite(s):** Completion of ENGL 1101 and a minimum grade of "C" in MATH 1112 or MATH 1113.

MATH 1501 Calculus I

4 Credit Hours. 0,4 Lecture Hours. 0,1 Lab Hours.

Topics to include functions, limits, continuity, the derivative, antirfferentiation, the definite integral, and applications. **Prerequisite(s):** MATH 1112 or MATH 1113.

MATH 2008 Foundations of Numbers and Operations**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is an Area F introductory course for early childhood education majors. This course will emphasize the understanding and use of the major concepts of numbers and operations. As a general theme, strategies of problem solving will be used and discussed in the context of various topics. This course is also part of the program of study for middle grade majors.

Prerequisite(s): A minimum grade of "C" in MATH 1111 or MATH 1101.**MATH 2010 Problem Solving for K-8 Teachers****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Students will learn, integrate and apply a variety of problem solving strategies to a range of mathematical problems from algebra, pre-calculus, and calculus. Students will learn, integrate and apply appropriate technology as a tool in the problem solving process. Designed for early childhood and middle grade majors.

Prerequisite(s): A minimum grade of "C" in MATH 1112 and MATH 3032.**MATH 2130 Discrete Mathematics****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Covers important discrete mathematical objects such as sets, relations and functions, graphs and trees. An introduction to mathematical logic and reasoning, and the concept of an algorithm and its complexity will be covered.

Prerequisite(s): Prior or concurrent enrollment in MATH 1232, or a minimum grade of "C" in MATH 1111 or MATH 1112 or MATH 1113 or MATH 1441 or MATH 2242.**MATH 2160 Linear Algebra****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Linear systems and matrices; vector spaces, linear independence, rank of a matrix; linear transformations; determinants; introduction to eigenvalues and eigenvectors; diagonalization; applications.

Prerequisite(s): A minimum grade of "C" in MATH 2242.**MATH 2242 Calculus II****4 Credit Hours. 4 Lecture Hours. 1 Lab Hour.**

Techniques and applications of integration; transcendental functions; indeterminate forms; improper integrals; parametric equations and polar coordinates; sequences and series; Taylor's theorem.

Prerequisite(s): a minimum grade of "C" in either MATH 1441 or MATH 1501.**MATH 2243 Calculus III****4 Credit Hours. 4 Lecture Hours. 0 Lab Hours.**

Vectors, curves, and surfaces; partial differentiation; multiple integrals; curve integrals and surface integrals; the theorem of Green and Stokes; the Divergence Theorem; introduction to differential equations.

Prerequisite(s): A minimum grade of "C" in MATH 2242.**MATH 2332 Mathematical Structures****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Topics include mathematical logic, methods of proofs, induction, set theory, relations, and functions. The course is primarily intended for mathematics and mathematics education majors as a first course in studying proof techniques and foundations of mathematics.

Prerequisite(s): A minimum grade of "C" in MATH 2242.**MATH 2430 Computing Techniques****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Fundamentals of numerical methods and development of programming techniques with implementation in the computer solution of problems in engineering.

Prerequisite(s): CSCI 1301 or ENGR 1731 or MATH 2242 or PHYS 2211K.**Corequisite(s):** MATH 3230.**MATH 3032 Foundations of Data Analysis and Geometry****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A study of basic probability, statistics and geometry, including two and three dimensional shapes and triangle congruenced similarity. For Early Childhood and Middle Grade majors only.

Prerequisite(s): A minimum grade of "C" in MATH 2008.**MATH 3230 Ordinary Differential Equations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study of differential equations involving functions of one variable. Topics include: linear and non-linear differential equations, initial value problems, existence and uniqueness theorems, systems of differential equations, stability, computational methods and Laplace transform methods.

Prerequisite(s): A minimum grade of "C" in MATH 2242.**MATH 3337 Probability****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An introduction to probability, random variables and discrete and continuous probability distributions for students in mathematics, engineering and the sciences including the social sciences and management science.

Prerequisite(s): A minimum grade of "C" in MATH 2242 or MATH 2242H.**MATH 3360 Modern Geometry****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An axiomatic approach to the fundamental ideas of Euclidean geometry, including congruence, similarities, circles, elementary transformations and constructions. An examination of non-Euclidean geometries.

Prerequisite(s): MATH 2332.**MATH 3932 Math Reasoning/Representations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A laboratory approach to the study of mathematics. Topics include methods of reasoning and proof; algebraic structures; conceptual consideration of functions; regression; recursion; proportional reasoning; analytic and transformational geometry; and rational, integer, and real number arithmetic.

Prerequisite(s): MATH 1441.**MATH 4000 Putnam Semina****1 Credit Hour. 0 Lecture Hours. 2 Lab Hours.**

A variety of mathematical problems, considered with the aim of developing problem solving techniques.

Prerequisite(s): MATH 2243.**MATH 4200 Actuarial Science Seminar****1-3 Credit Hours. 1-3 Lecture Hours. 0 Lab Hours.**

A study of topics related to a career in actuarial science.

Prerequisite(s): MATH 3337 and STAT 5330.**MATH 4400 Operations Research Seminar****1-3 Credit Hours. 1-3 Lecture Hours. 0 Lab Hours.**

A study of topics related to a career in operations research.

Prerequisite(s): MATH 5330.**MATH 4630 Game Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is designed to introduce students to the foundations of game theory and its applications. Students will use reasoning skills to deal with concepts of games, networks, economic development, and warfare.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and MATH 2130 or MATH 2332.**MATH 4825 Honors Research****2 Credit Hours. 2 Lecture Hours. 0 Lab Hours.**

Independent research under the guidance of a faculty member in the Department of Mathematical Sciences for mathematics majors in the University Honors Program. Students must complete four credit hours over two semesters to complete the honors requirements.

Prerequisite(s): Requires Junior status in Mathematics Program and good standing in the University Honors Program.

MATH 4890 Directed Study in Mathematics**1-3 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

Directed study under faculty supervision. Well prepared math majors may be permitted to enroll in an independent study upon the recommendation of a Mathematics faculty member.

Prerequisite(s): Permission of instructor and Department Chair required.

MATH 4920 Undergraduate Seminar**2 Credit Hours. 2 Lecture Hours. 0 Lab Hours.**

A specialized study of various topics in mathematics with the intention to engage students in independent reading, writing and presentation of these topics under the supervision of mathematics faculty.

Prerequisite(s): A minimum grade of "C" in MATH 2332 and MATH 2243.

MATH 4929 Honors Thesis**2 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

Written and oral presentation of results of research conducted in MATH 4825H (Honors Research). Honors thesis must follow the guidelines adopted by the University Honors Program. This course is required for mathematics majors in the University Honors Program.

Prerequisite(s): Junior level or above and good standing in the University Honors Program.

MATH 4930 Senior Research Project**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Main objective of this course is to engage senior undergraduate students in mathematical, statistical or computer science research and writing. Students will select advisors to work with on their projects. At least one oral presentation on the progress of their research during the semester is required. Also, a final written report on the project as well as a final oral presentation is required.

Prerequisite(s): Students must have at least 15 credit hours of upper level mathematics, statistics and/or computer science.

MATH 4961 Internship in Mathematics**3 Credit Hours. 0-1 Lecture Hours. 6-9 Lab Hours.**

Experience in a variety of mathematical applications suited to the educational and professional aspirations of the student, under the direction of faculty and appropriate off-campus supervisory personnel. Open to transient students only with the permission of the department chair.

MATH 4962 Internship in Mathematics**3 Credit Hours. 0 Lecture Hours. 6 Lab Hours.**

Experience in a variety of mathematical applications suited to the educational and professional aspirations of the student, under the direction of faculty and appropriate off-campus supervisory personnel. Open to transient students only with the permission of the department chair.

MATH 4963 Internship in Mathematics**3 Credit Hours. 0 Lecture Hours. 6 Lab Hours.**

Experience in a variety of mathematical applications suited to the educational and professional aspirations of the student, under the direction of faculty and appropriate off-campus supervisory personnel. Open to transient students only with the permission of the department chair.

MATH 5090 Selected Topics in Mathematics**1-3 Credit Hours. 1-3 Lecture Hours. 0-2 Lab Hours.**

Specialized study in a selected area of Mathematics. Graduate students will be given an extra assignment determined by the instructor that undergraduates will not be required to do.

Prerequisite(s): Permission of instructor required.

Cross Listing(s): MATH 5090G.

MATH 5090G Selected Topics in Mathematics**1-3 Credit Hours. 1-3 Lecture Hours. 0 Lab Hours.**

Specialized study in a selected area of Mathematics. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): Permission of instructor required.

Cross Listing(s): MATH 5090.

MATH 5130 Statistics and Probability for K-8 Teachers**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An in-depth study of topics in statistics, such as sampling and data analysis, and probability, such as counting methods, odds, and expected value. For Early Childhood and Middle Grade majors only.

Prerequisite(s): A minimum grade of "C" in MATH 3032.

Cross Listing(s): MATH 5130G.

MATH 5130G Statistics and Probability for K-8 Teachers**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An in-depth study of topics in statistics, such as sampling and data analysis, and probability, such as counting methods, odds, and expected value. For Early Childhood and Middle Grade majors only. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 3032.

Cross Listing(s): MATH 5130.

MATH 5135 Algebraic Connections for K-8 Teachers**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The evolution of algebraic concepts through the curriculum will be followed by how algebra is related to other areas of mathematics and real-world applications. For Early Childhood and Middle Grade majors only.

Prerequisite(s): A minimum grade of "C" in MATH 3032.

Cross Listing(s): MATH 5135G.

MATH 5135G Algebraic Connections for K-8 Teachers**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The evolution of algebraic concepts through the curriculum will be followed by how algebra is related to other areas of mathematics and real-world applications. For Early Childhood and Middle Grade majors only. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 3032.

Cross Listing(s): MATH 5135.

MATH 5136 History of Mathematics**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A survey of the historical development of mathematics. The emphasis will be on mathematical concepts, problem solving, and pedagogy from a historical perspective.

Prerequisite(s): A minimum grade of "C" in MATH 2242.

Cross Listing(s): MATH 5136G.

MATH 5136G History of Mathematics**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A survey of the historical development of mathematics. The emphasis will be on mathematical concepts, problem solving, and pedagogy from a historical perspective. Graduate students will be given an extra assignment determined by the instructor that undergraduates will not be required to do.

Prerequisite(s): A minimum grade of "C" in MATH 2242.

Cross Listing(s): MATH 5136.

MATH 5137 Geometry for K-8 Teachers**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A continuation of the study of geometry from MATH 3032. Focus will be on two and three dimensional geometry. Motion geometry and tessellations will also be covered. For Early Childhood and Middle Grade majors only.

Prerequisite(s): A minimum grade of "C" in MATH 3032.

Cross Listing(s): MATH 5137G.

MATH 5137G Geometry for K-8 Teachers**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A continuation of the study of geometry from MATH 3032. Focus will be on two and three dimensional geometry. Moton geometry and tessellations will also be covered. For Early Childhood and Middle Grade majors only. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 3032.**Cross Listing(s):** MATH 5137.**MATH 5230 Advanced Geometry****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Selected topics from Euclidean and Non-Euclidean Geometry. Graduate students will be given an extra assignment determined by the instructor that undergraduates will not be required to do.

Prerequisite(s): A minimum grade of "C" in MATH 3130 or one year of teaching high school mathematics.**Cross Listing(s):** MATH 5230G.**MATH 5230G Advanced Geometry****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Selected topics from Euclidean and Non-Euclidean Geometry. Graduate students will be given an extra assignment determined by the instructor that undergraduates will not be required to do.

Prerequisite(s): A minimum grade of "C" in MATH 3130 or one year of teaching high school mathematics.**Cross Listing(s):** MATH 5230.**MATH 5234 Number Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Introduction to the principal ideas of elementary number theory: Divisibility, congruencies, linear Diophantine Equations, Fermat's Theorem, Euler's Theorem, Pythagorean triples and the distribution of primes. Graduate students will be given an extra assignment determined by the instructor that undergraduates will not be required to do.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5234G.**MATH 5234G Number Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Introduction to the principal ideas of elementary number theory: Divisibility, congruencies, linear Diophantine Equations, Fermat's Theorem, Euler's Theorem, Pythagorean triples and the distribution of primes. Graduate students will be given an extra assignment determined by the instructor that undergraduates will not be required to do. **Prerequisite(s):** A minimum grade of "C" in MATH 2332. **Cross Listing(s):** MATH 5234.

MATH 5236 Patterns of Problem Solving**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A study of patterns involved in solving problems. Particular attention is paid to Polya's heuristics and his characterization of the problem solving process. The student will also solve many problems. The application of these techniques by mathematics teachers will be stressed.

Prerequisite(s): A minimum grade of "C" in MATH 1441 or permission of instructor.**Cross Listing(s):**MATH 5236G.**MATH 5236G Patterns of Problem Solving****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A continuation of the study of geometry from MATH 3032. Focus will be on two and three dimensional geometry. Moton geometry and tessellations will also be covered. For Early Childhood and Middle Grade majors only. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 1441, or permission of instructor.**Cross Listing(s):** MATH 5236.**MATH 5251 Combinatorics****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Counting principles such as permutations, combinations, derangements, pigeonhole, and inclusion/exclusion; partitions; generating functions; recurrence relations; applications from graph theory and applied algebra.

Prerequisite(s): MATH 2332.**Cross Listing(s):** MATH 5251G.**MATH 5251G Combinatorics****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Counting principles such as permutations, combinations, derangements, pigeonhole, and inclusion/exclusion; partitions; generating functions; recurrence relations; applications from graph theory and applied algebra. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5251.**MATH 5330 Operations Research****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Introduction to basic deterministic and probabilistic operations research models of decision problems. Mathematical methods of optimization for these models will be analyzed both analytically and numerically.

Prerequisite(s): A minimum grade of "C" in MATH 3337.**Cross Listing(s):** MATH 5330G.**MATH 5330G Operations Research****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Introduction to basic deterministic and probabilistic operations research models of decision problems. Mathematical methods of optimization for these models will be analyzed both analytically and numerically. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and MATH 3337.**Cross Listing(s):** MATH 5330.**MATH 5331 Analysis I****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Provides a transition from calculus to real analysis. Emphasis will be placed on understanding and constructing mathematical proofs. Rigorous development of fundamental concepts in analysis, including topics such as relations, functions, limits of functions, cardinality, topology of the reals, completeness axiom, compact sets, sequences, subsequence, continuity and differentiability.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and a minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5331G.**MATH 5331G Analysis I****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Provides a transition from calculus to real analysis. Emphasis will be placed on understanding and constructing mathematical proofs. Rigorous development of fundamental concepts in analysis, including topics such as relations, functions, limits of functions, cardinality, topology of the reals, completeness axiom, compact sets, sequences, subsequence, continuity and differentiability. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and MATH 2332.**Cross Listing(s):**MATH 5331.

MATH 5332 Analysis II**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A continuation of Analysis I, including topics such as Riemann integration, infinite series, sequences and series of functions, metric spaces, and normed spaces.

Prerequisite(s): A minimum grade of "C" in MATH 5331.**Cross Listing(s):** MATH 5332G.**MATH 5332G Analysis II****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A continuation of Analysis I, including topics such as Riemann integration, infinite series, sequences and series of functions, metric spaces, and normed spaces. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 5331 or MATH 5331G.**Cross Listing(s):** MATH 5332.**MATH 5333 Modern Algebra I****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is an introduction to the fundamental algebraic structures: groups, rings and fields. Topics covered include: binary operations, groups (permutation groups, subgroups, cyclic groups, group homomorphisms, factor groups), rings (integral domains, ring homomorphisms) and fields. The historical and mathematical connections to the secondary mathematics curriculum will be incorporated as appropriate.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5333G.**MATH 5333G Modern Algebra I****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is an introduction to the fundamental algebraic structures: groups, rings and fields. Topics covered include: binary operations, groups (permutation groups, subgroups, cyclic groups, group homomorphisms, factor groups), rings (integral domains, ring homomorphisms) and fields. The historical and mathematical connections to the secondary mathematics curriculum will be incorporated as appropriate. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5333.**MATH 5334 Modern Algebra II****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A continuation of the study of the fundamental algebraic structures. Topics to be covered include: isomorphism of groups, rings, fields, a deeper study of quotient structures and the isomorphism theorems, field of quotients, factorization of polynomials over a field, arithmetic properties of rings of polynomials over fields, extension fields, algebraic extensions, geometric constructions and the classic problems.

Prerequisite(s): A minimum grade of "C" in MATH 5333.**Cross Listing(s):** MATH 5334G.**MATH 5334G Modern Algebra II****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A continuation of the study of the fundamental algebraic structures. Topics to be covered include: isomorphism of groups, rings, fields, a deeper study of quotient structures and the isomorphism theorems, field of quotients, factorization of polynomials over a field, arithmetic properties of rings of polynomials over fields, extension fields, algebraic extensions, geometric constructions and the classic problems. Graduate students will complete assignments beyond the scope of the undergraduate requirements.

These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 5333 or MATH 5333G.**Cross Listing(s):** MATH 5334.**MATH 5335 Intermediate Linear Algebra****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

General vector spaces and bases, linear operators, least squares problems, eigenvalue problems, and applications of these concepts.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and MATH 2332.**Cross Listing(s):** MATH 5335G.**MATH 5335G Intermediate Linear Algebra****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

General vector spaces and bases, linear operators, least squares problems, eigenvalue problems, and applications of these concepts. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and MATH 2332.**Cross Listing(s):** MATH 5335.**MATH 5336 Applied Numerical Methods****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Introduction to scientific computation. Solutions of linear and nonlinear equations, polynomial interpolation, numerical differentiation and integration, data fitting, and other numerical methods.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and prior knowledge of a programming language.**Cross Listing(s):** MATH 5336G.**MATH 5336G Applied Numerical Methods****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Introduction to scientific computation. Solutions of linear and nonlinear equations, polynomial interpolation, numerical differentiation and integration, data fitting, and other numerical methods. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2160.**Cross Listing(s):** MATH 5336.**MATH 5337 Difference Equations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is an introduction to the theory and applications of difference equations. Topics include the difference calculus, first order linear difference equations, results and solutions of linear equations, applications, equations with variable coefficients and nonlinear equations that can be linearized.

Prerequisite(s): A minimum grade of "C" in MATH 2242 or MATH 2160.**Cross Listing(s):** MATH 5337G.**MATH 5337G Difference Equations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is an introduction to the theory and applications of difference equations. Topics include the difference calculus, first order linear difference equations, results and solutions of linear equations, applications, equations with variable coefficients and nonlinear equations that can be linearized. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2242 and MATH 2160.**Cross Listing(s):** MATH 5337.**MATH 5338 Methods of Applied Mathematics****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Methods of applied mathematics concentrating on techniques for the analysis of differential and integral equations. Topics include: Integral equations, differential operators, Fredholm alternative, distribution theory and Green's function methods.

Prerequisite(s): A minimum grade of "C" in MATH 3230.**Cross Listing(s):** MATH 5338G.

MATH 5338G Methods of Applied Mathematics**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Methods of applied mathematics concentrating on techniques for the analysis of differential and integral equations. Topics include: Integral equations, differential operators, Fredholm alternative, distribution theory and Green's function methods. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and MATH 3230.**Cross Listing(s):** MATH 5338.**MATH 5339 Partial Differential Equations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study of differential equations involving functions of more than one variable. Topics include: Laplace, heat and wave equations, boundary value problems, methods of separation of variables and eigenfunction expansions, Fourier series, Green's functions, maximum principle and computational methods.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and MATH 3230.**Cross Listing(s):** MATH 5339G.**MATH 5339G Partial Differential Equations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study of differential equations involving functions of more than one variable. Topics include: Laplace, heat and wave equations, boundary value problems, methods of separation of variables and eigenfunction expansions, Fourier series, Green's functions, maximum principle and computational methods. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and MATH 3230.**Cross Listing(s):** MATH 5339.**MATH 5412 Secondary School Curriculum and Methods****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Material and methods of teaching secondary school mathematics including field experience.

Prerequisite(s): A minimum grade of "C" in MATH 3932.**Cross Listing(s):** MATH 5412G.**MATH 5412G Sec School Curr and Methods****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Material and methods of teaching secondary school mathematics including field experience.

MATH 5430 Introduction to Mathematical Biology**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An introduction to applications of mathematics to various biological, ecological, physiological, and medical problems, which will be analyzed both analytically and numerically.

Prerequisite(s): A minimum grade of "C" in MATH 3230.**Cross Listing(s):** MATH 5430G.**MATH 5430G Introduction to Mathematical Biology****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An introduction to applications of mathematics to various biological, ecological, physiological, and medical problems, which will be analyzed both analytically and numerically. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 3230.**Cross Listing(s):** MATH 5430.**MATH 5431 Graph Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Graphs and digraphs, trees, connectivity, matchings, paths, cycles, bipartite graphs, Euler's formula, planar graphs, and graph coloring.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5431G.**MATH 5431G Graph Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Graphs and digraphs, trees, connectivity, matchings, paths, cycles, bipartite graphs, Euler's formula, planar graphs, and graph coloring. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisites: minimum grade of "C" in MATH 2332.**MATH 5433 Differential Geometry of Curves and Surfaces****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Differential geometry uses tools from calculus and linear algebra to study the geometric properties of smooth curves and surfaces in Euclidean spaces. Topics include: arc length surface area, geodesics, curvature, first and second fundamental forms, Gauss-Bonnet formula.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and MATH 2160.**Cross Listing(s):** MATH 5433G.**MATH 5433G Differential Geometry of Curves and Surfaces****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Differential geometry uses tools from calculus and linear algebra to study the geometric properties of smooth curves and surfaces in Euclidean spaces. Topics include: arc length surface area, geodesics, curvature, first and second fundamental forms, Gauss-Bonnet formula. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and MATH 2160.**Cross Listing(s):** MATH 5433.**MATH 5434 Functions of a Complex Variable****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Topics in complex variables including functions, limits, derivatives, integrals, the Cauchy-Riemann conditions, series representation of functions, Cauchy Integral formula, and elementary conformal mappings.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5434G.**MATH 5434G Functions of a Complex Variable****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Topics in complex variables including functions, limits, derivatives, integrals, the Cauchy-Riemann conditions, series representation of functions, Cauchy Integral formula, and elementary conformal mappings. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite: A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5434.**MATH 5435 Introduction to Topology****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An introduction to metric spaces, topological spaces, connectedness and compactness of topological spaces, and continuous functions on topological spaces.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5435G.

MATH 5435G Introduction to Topology**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An introduction to metric spaces, topological spaces, connectedness and compactness of topological spaces, and continuous functions on topological spaces. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2332.**Cross Listing(s):** MATH 5435.**MATH 5436 Introduction to Fractals****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Fractals as nonlinear systems involving feedback and iteration. Classical fractals, limits and self-similarity. Fractal dimensions. Encoding of fractals. Decoding of fractals. Iterated function systems.

Prerequisite(s): A minimum grade of "C" in MATH 5331.**Cross Listing(s):** MATH 5436G.**MATH 5436G Introduction to Fractals****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Fractals as nonlinear systems involving feedback and iteration. Classical fractals, limits and self-similarity. Fractal dimensions. Encoding of fractals. Decoding of fractals. Iterated function systems. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 5331 or MATH 5331G.**Cross Listing(s):** MATH 5436.**MATH 5437 Mathematics and Computation of Curves and Surfaces****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is a study of the mathematical and computational techniques used for the computer generation of curves and surfaces. The primary representations for the curves and surfaces are univariate and multivariate polynomials and splines in the Bernstein/Bezier and B-spline bases. These curves and surfaces are used for data fitting (interpolation and smoothing) and approximation. Topics include: recursion, smoothness, surfaces over grids, surfaces over triangulations, simplex and box splines, variational curves and surfaces, transformations and projections.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and MATH 2160.**Cross Listing(s):** MATH 5437G.**MATH 5437G Mathematics and Computation of Curves and Surfaces****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is a study of the mathematical and computational techniques used for the computer generation of curves and surfaces. The primary representations for the curves and surfaces are univariate and multivariate polynomials and splines in the Bernstein/Bezier and B-spline bases. These curves and surfaces are used for data fitting (interpolation and smoothing) and approximation. Topics include: recursion, smoothness, surfaces over grids, surfaces over triangulations, simplex and box splines, variational curves and surfaces, transformations and projections. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2243 and MATH 2160.**Cross Listing(s):** MATH 5437.**MATH 5480 Optimization****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Operations research topics including nonlinear programming, network analysis, Markov chains, game theory, and inventory theory.

Prerequisite(s): MATH 2160.**Cross Listing(s):** MATH 5480G.**MATH 5480G Optimization****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Operations research topics including nonlinear programming, network analysis, Markov chains, game theory, and inventory theory. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2160. Cross Listing(s): MATH 5480.**MATH 5530 Mathematics for Scientists and Engineers****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A survey of mathematical topics useful in the study of areas of applied sciences such as physics, engineering and computer science. Topics include: linear algebra and matrices, ordinary differential equations, partial differential equations, Fourier series, vector calculus, complex variables, numerical methods, probability and graph theory. For non-math majors only.

Prerequisite(s): A minimum grade of "C" in MATH 2242.**Cross Listing(s):** MATH 5530G.**MATH 5530G Mathematics for Scientists and Engineers****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A survey of mathematical topics useful in the study of areas of applied sciences such as physics, engineering and computer science. Topics include: linear algebra and matrices, ordinary differential equations, partial differential equations, Fourier series, vector calculus, complex variables, numerical methods, probability and graph theory. For non-math majors only. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2242.**Cross Listing(s):** MATH 5530.**MATH 5539 Mathematical Models****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course introduces students to a variety of mathematical tools used for solving real world problems, with the focus on identifying the problem, constructing an appropriate model, and finding the best available method to solve it.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and MATH 3230.**Cross Listing(s):** MATH 5539G.**MATH 5539G Mathematical Models****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course introduces students to a variety of mathematical tools used for solving real world problems, with the focus on identifying the problem, constructing an appropriate model, and finding the best available method to solve it. Graduate students will complete assignments beyond the scope of the undergraduate requirements. These assignments require higher-level mastery of the subject matter and additional deliverables representative of graduate-level work, as determined by the instructor.

Prerequisite(s): A minimum grade of "C" in MATH 2160 and MATH 3230.**Cross Listing(s):** MATH 5539.**MATH 6230 Fundamental Ideas of Calculus****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A review of the principal ideas of calculus, with emphases on concepts. Intended for Mathematics Education majors.

Prerequisite(s): A minimum grade of "C" in MATH 1441; permission of instructor.**MATH 6900 Special Topics in Mathematics****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Selected topics in mathematics.

MATH 6910 Topics in Analysis**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Selected topics in an area of real or complex analysis.

MATH 6920 Topics in Geometry**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Topics from Euclidean and non-Euclidean geometry.

MATH 6930 Topics in Applied Mathematics**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Selected topics in an area of mathematics that has broad applications to disciplines outside of mathematics.

MATH 7090 Selected Topics in Mathematics**1-3 Credit Hours. 1-3 Lecture Hours. 0 Lab Hours.**

Specialized study in a selected area of Applied Mathematics.

Prerequisite(s): Permission of instructor.**MATH 7130 Mathematical Optimization Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The course covers fundamentals of mathematical optimization theory.

Topics include: elements of convex analysis, first and second order necessary and sufficient optimality conditions for unconstrained and constrained optimization problems, Lagrange multiplier theory, Lagrange duality theory, and an overview of important optimization techniques for convex, conic, semidefinite and complementarity problems.

Prerequisite(s): A minimum grade of "C" in MATH 5331.**MATH 7132 Methods of Optimization****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The first part of the course provides a brief introduction to the foundations of optimization, including optimality conditions. The second part concentrates on selected methods for unconstrained and constrained optimization problems. These include but are not limited to: line search methods, gradient methods, Newton-type methods, trust region methods, non-gradient methods, penalty and barrier methods, interior-point methods, methods of feasible directions and dual methods. Selected methods will be implemented on the computer. Prior completion of MATH 5330 is recommended.

Prerequisite(s): A minimum grade of "C" in MATH 5331.**MATH 7210 Quant Meth Decision Making****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Intermediate level linear models concentrating on multiple regression, linear programming techniques, queuing theory, and simulation.

MATH 7231 Advanced Numerical Analysis I**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An in-depth study of computer arithmetic, the solution of non-linear equations, the solution of systems of linear equations, eigenvalue problems and interpolation. Algorithms and methods are developed and then implemented on a computer.

Prerequisite(s): A minimum grade of "C" in MATH 5336 or MATH 5336G.**MATH 7232 Advanced Numerical Analysis II****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An in-depth study of orthogonal polynomials, numerical integration, and numerical solutions of ordinary and partial differential equations. Development and computer implementation of algorithms and methods.

Prerequisite(s): A minimum grade of "C" in MATH 7231.**MATH 7234 Advanced Linear Algebra****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study of linear maps on finite dimensional vector spaces. Topics include: diagonalization (direct sums, invariant subspaces and Cayley-Hamilton theorem for linear operators), inner product spaces (self-adjoint, orthogonal operators, orthogonal projections and the spectral theorem, bilinear and quadratic forms), canonical forms (Jordan and rational forms, minimal polynomials), special matrices (non-negative matrices), and the exponential of a linear operator.

Prerequisite(s): A minimum grade of "C" in MATH 5335.**MATH 7235 Analytic Number Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A study of topics from the classical analytic theory of numbers. Topics will be chosen from arithmetic functions, the distribution of primes, congruences, the Riemann-zeta functions, the prime number theorem, Eisenstein series, quadratic residues, Dirichlet series, Euler products, the Dedekind eta function, the Jacobi theta functions, integer partitions, and modular forms.

Prerequisite(s): A minimum grade of "C" in MATH 5234 and MATH 5434.**MATH 7236 Advanced Ordinary Differential Equations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The theory of ordinary differential equations and dynamical systems.

Topics include: Sturm-Liouville boundary value problems, eigenfunction expansions, Lyapunov stability, limit cycles, Poincaré Bendixson theorem, Floquet's theory and Invariance theorems.

Prerequisite(s): A minimum grade of "C" in MATH 3230.**MATH 7237 Mathematical Control Theory****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

State-space techniques from modern control system theory. Topics include realization theory for MIMO systems, state-space techniques for feedback control, closed loop observer design, and state-space techniques in optimal control.

Prerequisite(s): A minimum grade of "C" in MATH 3230 and MATH 5336G.**MATH 7330 Functional Analysis****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study of normed linear spaces and linear operators. Topics include: Hilbert spaces (projection theorem, Riesz representation, Parseval relation); Banach spaces (convexity, duality, bounded and compact operators, theorems of Hahn-Banach, Banach-Steinhaus, open mapping, closed graph, Fredholm alternative); Stone-Weierstrass and Banach fixed point theorems.

Prerequisite(s): A minimum grade of "C" in MATH 5332 and MATH 5335.**MATH 7331 Real Analysis****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**Theory of Lebesgue measure and integration, monotone convergence, the dominated convergence theorem, Fubini's theorem, Radon-Nikodym theorem, Riesz representation theorem, L_p and l_p spaces, functions of finite variation, Stieltjes integral, absolute continuity.**Prerequisite(s):** A minimum grade of "C" in MATH 5331.**MATH 7332 Advanced Partial Differential Equations****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The theory of linear and nonlinear partial differential equations. Topics include: Classical theory of elliptic, parabolic and hyperbolic partial differential equations and their solutions, potential theory, maximum principle, existence of weak solutions, regularity of solutions, Duhamel's principle and Cauchy's problem.

Prerequisite(s): A minimum grade of "C" in MATH 5339 or MATH 5339G.**MATH 7333 Complex Analysis****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An in-depth study of functions of one complex variable. Topics include: properties of holomorphic, harmonic, meromorphic and entire functions (open mapping, maximum modulus, mean value, Poisson's, Rouché's, Liouville's, Picard's and Mittag-Leffler's theorems), residue theory (residue theorem, argument principle and applications), conformal mappings (Möbius and Christoffel-Schwarz canonical transformations, Riemann mapping theorem), analytic continuation (monodromy theorem, Schwarz reflection principle, Riemann surfaces and multi-valued functions).

Prerequisite(s): A minimum grade of "C" in MATH 5331 and MATH 5434.

MATH 7334 Approximation Theory**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study of the approximation of functions in normed linear spaces. The course emphasizes the theory of interpolation and approximation by polynomials, rational functions and spline functions. Main topics include: best approximation, order of approximation, interpolation, existence and uniqueness of best approximants, theorems by Weierstrass, Haar, Chebyshev, Bernstein, Markov, Korovkin, Schoenberg, and applications.

Prerequisite(s): A minimum grade of "C" in MATH 5331 and MATH 5335.**MATH 7430 Abstract Algebra I****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course provides a comprehensive study of group theory. The course begins with basic concepts of group theory (binary structures, subgroups, homomorphisms) and continues with the study of normal subgroups, quotient groups and the isomorphism theorems. Further topics to be studied include group actions, Sylow's theorem and the structure of finitely generated abelian groups.

Prerequisite(s): A minimum grade of "C" in MATH 5333 or MATH 5333G.**MATH 7431 Abstract Algebra II****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The course provides a comprehensive study of rings and fields. The course begins with the basic concepts (rings, subrings, ideals, quotient rings, homomorphisms), continues with the arithmetic of rings, applications to rings of polynomials and field theory, and concludes with a chapter on Galois theory that links field theory and group theory.

Prerequisite(s): A minimum grade of "C" in MATH 7430.**MATH 7432 Differential Geometry of Manifolds****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study and applications of calculus on manifolds. Topics include: atlases, tangent spaces, differentiable maps; immersions and submanifolds, submersions and quotient manifolds; matrix groups and their Lie algebras; vector fields and flows; differential forms, exterior derivative, and Lie derivative.

Prerequisite(s): A minimum grade of "C" in MATH 3230 and MATH 5335.**MATH 7435 Elements of Algebraic Topology****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The study of the topology of geometric objects from the algebraic viewpoint, in particular using homotopy and homology groups. Main topics: Topological manifolds, homotopy, fundamental group, free groups, covering spaces, and homology.

Prerequisite(s): A minimum grade of "C" in MATH 5435.**MATH 7530 Problem Solving****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A study of patterns involved in solving problems. Particular attention is paid to Poly's heuristics and his characterization of the problem-solving process. The application of these techniques by mathematics teachers will be stressed.

MATH 7610 Graduate Seminar**1 Credit Hour. 1 Lecture Hour. 0 Lab Hours.**

Under supervision of one or more faculty members, each student will choose topics related to his or her concentration, or topics of interest to the class, read and research on them, then make presentations in front of the class or a larger audience. Students will also attend presentations of internal and external speakers on mathematical sciences.

Prerequisite(s): A minimum grade of "C" in MATH 5332 or MATH 5335 or STAT 5531 or MATH 7231.**MATH 7890 Directed Study in Mathematics****1-3 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

Directed study under faculty supervision.

Prerequisite(s): Permission of instructor and Department Chair required.**MATH 7895 Research****1-3 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

Graduate students will conduct a program of independent research under the direction of a thesis advisor or an advisory committee on a topic in Mathematical Sciences. Results of the research will be presented as a thesis in partial fulfillment of the requirement of the Master of Science degree.

MATH 7900 Special Topics in Mathematics**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Selected topics in mathematics.

MATH 7999 Thesis**1-3 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

Results of independent research conducted under the direction of a thesis advisor will be presented as a thesis in partial fulfillment of the Master of Science degree. The thesis will be defended before an advisory committee.

MATH 8540 Fundamentals of Probability**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A study of fundamental ideas of probability with emphasis on topics, examples, and applications for secondary mathematics teachers.

MATH 8570 Transformation Geometry**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Algebraic operations on the complex numbers and their corresponding geometric interpretations; a characterization of isometries of the complex plane as translations, rotations, reflections and glide reflections; a study of isometries as groups; similarities, some classic theorems.

MATH 8580 Calculus First Three Dimension**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A survey of the basic notions of differential and integral calculus for functions in dimensions one, two, and three, presented for students with previous courses in calculus with emphasis on concepts, applications, problem solving and historical development.