Mathematics (MATH)

MATH _0110: Intermediate Algebra
MATH _0110 is a preparatory course for college algebra that carries no credit towards any baccalaureate degree. However, the grade received in MATH _0110 does count towards a student's overall GPA. The course covers operations with real numbers, graphs of functions, domain and range of functions, linear equations and inequalities, quadratic equations; operations with polynomials, rational expressions, exponents and radicals; equations of lines. Emphasis is also put on problem-solving.

Credit Hours: 3

MATH 1050: Quantitative Reasoning
Promotes mathematical literacy among students. This course will cover important mathematical ideas and problem solving skills in the context of science, technology, and/or society. Topics may include: logic and critical thinking, Venn Diagrams, problem solving, sets, units of measure, percentages and ratios, counting and probability, exponential growth and decay, linear and exponential models. Quantitative Reasoning is designed to stimulate interest in and appreciation of mathematics and quantitative reasoning as valuable tools for comprehending the world in which we live. This course does not satisfy the prerequisite of any other MATH course.

Credit Hours: 3
Prerequisites: C- or higher in MATH _0110 or a sufficient score on the myMath test

MATH 1100: College Algebra
A review of exponents, order of operations, factoring, and simplifying polynomial, rational, and radical expressions. Topics include: linear, quadratic, polynomial, rational, inverse, exponential, and logarithmic functions and their applications. Students will solve equations involving these functions, and systems of linear equations in two variables, as well as inequalities. See the Math website for specific requirements. A student may receive at most 5.0 credit hours among MATH 1100, MATH 1120, MATH 1140, MATH 1160.

Credit Hours: 3
Prerequisites: C- or higher in MATH _0110 or a sufficient score on the ALEKS exam or MyMathTest Intermediate Algebra score of 70% or higher

MATH 1140: Trigonometry
A student may receive only 5 credits from among MATH 1100, MATH 1140, and MATH 1160. A Student may receive at most 5.0 credit hours from MATH 1100, MATH 1120, MATH 1140, and MATH 1160.

Credit Hours: 2
Prerequisites: C- or higher in MATH 1100 or sufficient ALEKS score or MyMathTest College Algebra score of 70% or higher

MATH 1160: Precalculus Mathematics
Review of elementary algebra. Background material for MATH 1500, including algebraic, trigonometric, logarithmic, exponential functions. A student may receive at most 5 credits from among MATH 1100, MATH 1140, and MATH 1160.

Credit Hours: 5

Prerequisites: B+ or higher in MATH _0110 (at MU), or C- or higher in MATH 1100, or sufficient ALEKS score or MyMathTest College Algebra score of 60% or higher

MATH 1300: Finite Mathematics
A selections of topics in finite mathematics such as: basic financial mathematics, counting methods and basic probability and statistics, systems of linear equations and matrices. Warning: without a College Algebra exemption, a sufficient ALEKS score will not suffice unless it is a proctored exam (for MATH 1100 credit).

Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 1100, or MATH 1160, or both a College Algebra exemption and sufficient ALEKS score

MATH 1360: Geometric Concepts
This course is primarily for education majors. This course covers topics of Euclidean geometry such as the study of points, lines, angles, polygons, circles, congruence, similarity, transformations, symmetry, area, surface area, arc length, and volume. Polyhedra, spheres, cones, and other solids are discussed. The course includes constructions and proofs, and uses inductive and deductive reasoning throughout. Math Reasoning Proficiency Course.

Credit Hours: 3
Prerequisites: C- or higher in MATH 1100 or sufficient ALEKS exam score or MATH 1160 or equivalent

MATH 1300H: Analytic Geometry and Calculus I - Honors
Elementary analytic geometry, functions, limits, continuity, derivatives, antiderivatives, definite integrals. A student may receive credit for MATH 1320 or MATH 1400 but not both. A student may receive at most 5 units of credit among the MATH 1320 or MATH 1400 and MATH 1500. Math Reasoning Proficiency Course.

Credit Hours: 5
Prerequisites: grade of C- or higher in MATH 1100, or MATH 1160, or sufficient ALEKS score

MATH 1400: Calculus for Social and Life Sciences I
The real number system, functions, analytic geometry, derivatives, integrals, maximum-minimum problems. No credit for students who have completed a calculus course. A student may receive credit for MATH 1320 or MATH 1400 but not both. A student may receive at most 5 units of credit among the MATH 1320 or MATH 1400 and MATH 1500. Math Reasoning Proficiency Course.

Credit Hours: 3
Prerequisites: grade of C- or higher in MATH 1100, or MATH 1160, or sufficient ALEKS score

MATH 1400H: Calculus for Social and Life Sciences I - Honors
Elementary analytic geometry, functions, limits, continuity, derivatives, antiderivatives, definite integrals. A student may receive at most 5 units of credit among the Mathematics courses MATH 1320 or MATH 1400 and MATH 1500. Math Reasoning Proficiency Course.

Credit Hours: 5
Prerequisites: grade of C- or higher in MATH 1100 or C - or higher in both MATH 1100 and MATH 1140 or sufficient ALEKS score or MyMathTest PreCalculus score of 70% or higher

MATH 1500H: Analytic Geometry and Calculus I - Honors
Elementary analytic geometry, functions, limits, continuity, derivatives, antiderivatives, definite integrals. Honors eligibility required. A student may receive at most 5 units of credit among MATH 1320 or MATH 1400 and MATH 1500. Math Reasoning Proficiency course.

Credit Hours: 5
Prerequisites: C- or higher in MATH 1160 or C- in both MATH 1100 and MATH 1140 and sufficient ALEKS score. Honors Eligibility required
MATH 1601: Selected Topics in Mathematics-General
The special topics covered may vary from term to term. This course may be repeated.
Credit Hour: 1-3
Prerequisites: instructor's consent

MATH 1602: Selected Topics in Mathematics-Biological/Physical/Math
The special topics covered may vary from term to term. This course may be repeated.
Credit Hour: 1-3
Prerequisites: instructor's consent

MATH 1700: Calculus II
Definite integrals, applications and techniques of integration, elementary transcendental functions, infinite series. Math Proficiency Reasoning course.
Credit Hours: 5
Prerequisites: a grade of C- or better in MATH 1500

MATH 1700H: Calculus II - Honors
Definite integrals, applications and techniques of integration, elementary transcendental functions, infinite series. Math Reasoning Proficiency course.
Credit Hours: 5
Prerequisites: a grade of C- or better in MATH 1500. Honors eligibility required

MATH 2100: Calculus for Social and Life Sciences II
Riemann integral, transcendental functions, techniques of integration, improper integrals and functions of several variables. No credit for students who have completed two calculus courses. Math Reasoning Proficiency course.
Credit Hours: 3
Prerequisites: C- or higher in MATH 1320 or MATH 1400 or MATH 1500

MATH 2300: Calculus III
Vectors, solid analytic geometry, calculus of several variables. Math Reasoning Proficiency course.
Credit Hours: 3
Prerequisites: grade of C- or better in MATH 1700

MATH 2300H: Calculus III - Honors
Vectors, solid analytic geometry, calculus of several variables. Math Reasoning Proficiency course.
Credit Hours: 3
Prerequisites: grade of C or better in MATH 1700. Honors eligibility required

MATH 2320: Discrete Mathematical Structures
Sets, functions, logic, relations, induction, recursion, counting techniques, graphs, trees, algorithms. Math Reasoning Proficiency course.
Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 1700

MATH 3000: Introduction to Advanced Mathematics
Gateway to theoretical math courses. Focus on reading and writing math proofs/developing background needed in Adv Calc/Abstract Alg. Topics include logic, set theory, properties of functions and integers, the real number system, completeness of the real numbers, sequences of real numbers.
Credit Hours: 3
Prerequisites: Consent of Department required. Recommended MATH 1700

MATH 3000W: Introduction to Advanced Mathematics - Writing Intensive
Gateway to theoretical math courses. Focus on reading and writing math proofs/developing background needed in Adv Calc/Abstract Alg. Topics include logic, set theory, properties of functions and integers, the real number system, completeness of the real numbers, sequences of real numbers.
Credit Hours: 3
Prerequisites: Consent of Department required. Recommended MATH 1700

MATH 4002: Topics in Mathematics-Biological Sciences
Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. May repeat for credit with Departmental consent.
Credit Hour: 1-6
Prerequisites: MATH 2300 and instructor's consent

MATH 4006: Topics in Mathematics-Mathematical Sciences
Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. May repeat for credit with Departmental consent.
Credit Hour: 1-6
Prerequisites: MATH 2300 and instructor's consent

MATH 4007: Topics in Mathematics-Physical Sciences
Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. May repeat for credit with Departmental consent.
Credit Hour: 1-6
Prerequisites: MATH 2300 and instructor's consent

MATH 4060: Connecting Geometry to Middle and Secondary Schools
(cross-leveled with MATH 7060). Euclidean foundations, logic, Euler Characteristic, congruence, area, Pick’s Theorem, volume, Cavalieri’s Principle, surface area, similarity, symmetry, transformations, matrices, introduction to spherical geometry.
Credit Hours: 3
Prerequisites: Consent of Department required
Recommended: MATH 1360 or MATH 1500
MATH 4070: Connecting Algebra to Middle and Secondary Schools (cross-leveled with MATH 7070). A detailed study of integer and rational arithmetic and algebra. Topics include: Binomial Theorem, induction, division algorithm, Euclid's Algorithm, Fundamental Theorem of Arithmetic, Pythogorean triples, modular arithmetic and generalizations to polynomials, matrices and other axiomatic structures.

**Credit Hours:** 3  
**Prerequisites:** MATH 1400, enrollment is restricted to Math Education majors

MATH 4080: Calculus Connections  
Course topics include: sequences, series, functions, limits, continuity, differentiation, optimization, curve sketching, antidifferentiation, areas of plane regions, lengths of plane curves, areas of surfaces of revolution, and volumes of solids.

**Credit Hours:** 3  
**Prerequisites:** MATH 1160, enrollment is restricted to Math Education majors

MATH 4100: Differential Equations (cross-leveled with MATH 7100). Traditional introductory course in ordinary differential equations. Includes 1st and 2nd order linear differential equations with numerous applications; Laplace transforms; power series solutions; numerical methods, linear systems.

**Credit Hours:** 3  
**Prerequisites:** Grade of C- or better in MATH 2300 or MATH 2320.

MATH 4140: Matrix Theory (cross-leveled with MATH 7140). Basic properties of matrices, determinants, vector spaces, linear transformations, eigenvalues, eigenvectors, and Jordan normal forms. Introduction to writing proofs.

**Credit Hours:** 3  
**Prerequisites:** Grade of C- or better in MATH 2300 or MATH 2320. Writing intensive sections require ENGLSH 1000

MATH 4140W: Matrix Theory - Writing Intensive  
Basic properties of matrices, determinants, vector spaces, linear transformations, eigenvalues, eigenvectors, and Jordan normal forms. Introduction to writing proofs.

**Credit Hours:** 3  
**Prerequisites:** Grade of C- or better in MATH 2300 or MATH 2320. Writing intensive sections require ENGLSH 1000

MATH 4150: History of Mathematics  
This is a history course with mathematics as its subject. Includes topics in the history of mathematics from early civilizations onwards. The growth of mathematics, both as an abstract discipline and as a subject which interacts with others and with practical concerns, is explored. Prerequisites or Cirequisite: MATH 2300 or MATH 2340. Writing intensive sections require ENGLSH 1000.

**Credit Hours:** 3

MATH 4150W: History of Mathematics - Writing Intensive  
This is a history course with mathematics as its subject. Includes topics in the history of mathematics from early civilizations onwards. The growth of mathematics, both as an abstract discipline and as a subject which interacts with others and with practical concerns, is explored. Prerequisites or Cirequisite: MATH 2300 or MATH 2340. Writing intensive sections require ENGLSH 1000.

**Credit Hours:** 3

MATH 4300: Numerical Analysis (cross-leveled with MATH 7300). Machine arithmetic, approximation and interpolation, numerical differentiation and integration, nonlinear equations, linear systems, differential equations, error analysis. Selected algorithms will be programmed for solution on computers.

**Credit Hours:** 3  
**Prerequisites:** Grade of C- or better in MATH 2300 and MATH 4100


**Credit Hours:** 3  
**Prerequisites:** MATH 2300 and familiarity with software such as Mathematica, MatLab, Maple, etc

MATH 4315: Introduction to Mathematical Statistics (same as STAT 4710; cross-leveled with MATH 7315, STAT 7740). Introduction to theory of probability and statistics using concepts and methods of calculus.

**Credit Hours:** 3  
**Prerequisites:** MATH 2300 or instructor's consent

MATH 4320: Introduction to Probability Theory (same as STAT 4750; cross-leveled with MATH 7320, STAT 7750). Probability spaces; random variables and their distributions; repeated trials; probability limit theorems.

**Credit Hours:** 3  
**Prerequisites:** MATH 2300 or instructor's consent

MATH 4330: Theory of Numbers (cross-leveled with MATH 7330). Divisibility, factorization, arithmetic functions, means value theorems, distribution of prime numbers, congruences, primitive roots, character theory, Riemann zeta function, and Dirichlet L-functions.

**Credit Hours:** 3  
**Prerequisites:** Grade of C- or higher in MATH 2300. Recommended MATH 2320


**Credit Hours:** 3  
**Prerequisites:** MATH 2300
MATH 4355: Mathematics of Financial Derivatives I
(cross-leveled with MATH 7355). Long and short positions, forward contracts, exchange traded index futures, European and American call and put options, put-call parity, trading and hedging strategies, synthetic transactions, arbitrage, currency options, fixed income portfolio management, duration, convexity, interest rate and currency swaps, embedded options.

Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 2300 and either STAT 2500 or STAT 4710 or MATH 4315

MATH 4370: Interest Theory
(cross-leveled with MATH 7370). This course covers the concepts underlying the theory of interest and their applications to valuation of various cash flows, annuities certain, bonds, and loan repayment. This course is designed to help students prepare for Society of Actuaries exam FM (Financial Mathematics). It is oriented towards problem solving techniques applied to real-life situations and illustrated with previous exam problems.

Credit Hours: 3
Prerequisites: grade of C-or better in MATH 2300

MATH 4371: Models for Life Contingencies I
(cross-leveled with MATH 7371). The sequence MATH 4371 - MATH 4372 is designed to help students prepare for the Society of Actuaries exam LTAM (Long-Term Actuarial Mathematics). This course teaches the basic theory of life contingent actuarial models and the applications of those models to insurance and other financial risks. Covered topics include: survival models, life tables and selection, insurance benefits, life annuities, premium calculation and reserves.

Credit Hours: 3
Prerequisites: MATH 4320 or STAT 4750, and MATH 4370

MATH 4372: Models for Life Contingencies II
(cross-leveled with MATH 7372). The sequence MATH 4371 - MATH 4372 is designed to help students prepare for the Society of Actuaries exam LTAM (Long-Term Actuarial Mathematics). This course extends the life-death contingency models of Math 4371 to more general multiple-state and multiple-life models applied to problems involving a wide range of insurance and pension benefits. Covered topics include: Markov chains, multiple decrement models, joint life and last survivor benefits, pension mathematics, profit testing.

Credit Hours: 3
Prerequisites: A grade of C- or better in MATH 4371

MATH 4400: Introduction to Topology

Credit Hours: 3
Prerequisites: MATH 2300

MATH 4500: Applied Analysis

Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 4100

MATH 4510: Higher Algebra
(cross-leveled with MATH 7510). Introduction to rings, integral domains, fields, groups.

Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 2300 or MATH 2320

MATH 4520: Statistical Inference I
(same as STAT 4760; cross-leveled with MATH 7520, STAT 7760). Sampling; point estimation; sampling distribution; tests of hypotheses; regression and linear hypotheses.

Credit Hours: 3
Prerequisites: MATH 4320

MATH 4540: Mathematical Modeling I
(cross-leveled with MATH 7540). Solution of problems from industry, physical, social and life sciences, economics, and engineering using mathematical models.

Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 2300 and MATH 4100
Recommended: Familiarity with software such as MATHEMATICA, MATLAB, or MAPLE

MATH 4550: Mathematical Modeling II
(cross-leveled with MATH 7550). Solution of problems from industry, physical, social and life sciences, economics, and engineering using mathematical models.

Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 2300 and MATH 4100
Recommended: Familiarity with software such as MATHEMATICA, MATLAB, or MAPLE

MATH 4560: Nonlinear Dynamics, Fractals and Chaos
(cross-leveled with MATH 7560). Conceptual introduction to nonlinear dynamics, bifurcation and stability of steady states, chaos in nonlinear differential equations and maps, fractal dimension, strange attractors, and applications to physical science.

Credit Hours: 3
Prerequisites: MATH 4100 or MATH 7100, MATH 4140 or MATH 7140, and familiarity with software such as MATHEMATICA, MATLAB, or MAPLE

MATH 4590: Mathematics of Financial Derivatives II

Credit Hours: 3
Prerequisites: MATH 4370 and either STAT 2500 or STAT 4710 or MATH 4315
Recommended: MATH 4355

MATH 4700: Advanced Calculus of One Real Variable I
(cross-leveled with MATH 7700). Basic topology of the real line, numerical sequences and series, continuity, differentiability, Riemann integration, uniform convergence, power series.

Credit Hours: 3
Prerequisites: Grade of C - or higher in MATH 3000
MATH 4720: Introduction to Abstract Algebra I
(cross-leveled with MATH 7720). Basic properties of integers, fundamental theorem of arithmetic, introduction to groups, rings and fields.
Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 3000

MATH 4900: Advanced Multivariable Calculus
(cross-leveled with MATH 7900). This is a course in calculus in several variables. The following is core material: Basic topology of n-dimensional Euclidian space; limits and continuity of functions; the derivative as a linear transformation; Taylor's formula with remainder; the Inverse and Implicit Function Theorems, change of coordinates; integration (including transformation of integrals under changes of coordinates); Green's Theorem. Additional material from the calculus of several variables may be included, such as Lagrange multipliers, differential forms, etc.
Credit Hours: 3
Prerequisites: MATH 4720

MATH 4920: Introduction to Abstract Linear Algebra
(cross-leveled with MATH 7920). Study of vector spaces over arbitrary fields: topics include linear maps on finite dimensional vector spaces, bilinear and multi-linear forms, invariant subspaces and canonical forms.
Credit Hours: 3
Prerequisites: Grade of C- or higher in MATH 4700

MATH 4940: Introduction to Complex Variables
(cross-leveled with MATH 7940). Complex functions, contour integration, power series, residues and poles, conformal mapping.
Credit Hours: 3
Prerequisites: MATH 4110 or MATH 4700

MATH 4960: Special Readings in Mathematics
Credit Hour: 1-3
Prerequisites: Consent of Department required

MATH 4996: Honors in Mathematics
Special work for senior B.A. Honors and B.S. Honors candidates.
Credit Hours: 2
Prerequisites: Consent of Department required

MATH 7060: Connecting Geometry to Middle and Secondary Schools
(cross-leveled with MATH 4060). Euclidian foundations, basic concepts of symbolic logic, polyhedra, Euler Characteristic, congruence, area, Pick's Theorem, volume, Cavalier's Principles, surface area, similarity, reflections, translations, rotations, symmetry, vectors, general transformations, determinants, matrices, transformations using matrices, brief introduction to spherical geometry.
Credit Hours: 3
Prerequisites: MATH 1360 or MATH 1500, enrollment is restricted to Math Education majors

MATH 7070: Connecting Algebra to Middle and Secondary Schools
(cross-leveled with MATH 4070). A detailed study of integer and rational arithmetic and algebra. Topics include: Binomial Theorem, induction, division algorithm, Euclid's Algorithm, Fundamental Theorem of Arithmetic, Pythogorian triples, modular arithmetic and generalizations to polynomials, matrices and other axiomatic structures. Prerequisites: MATH 1400, enrollment is restricted to Math Education majors
Credit Hours: 3

MATH 7100: Differential Equations
(cross-leveled with MATH 4100). Traditional introductory course in ordinary differential equations. Includes 1st and 2nd order linear differential equations with numerous applications; Laplace transforms; power series solutions; numerical methods, linear systems.
Credit Hours: 3
Prerequisites: graduate standing and MATH 2300

MATH 7140: Matrix Theory
(cross-leveled with MATH 4140). Basic properties of matrices, determinants, vector spaces, linear transformations, eigenvalues, eigenvectors, and Jordan normal forms. Introduction to writing proofs.
Credit Hours: 3
Prerequisites: graduate standing and one of MATH 2300, MATH 2320, MATH 2120 or MATH 2340

MATH 7150: History of Mathematics
This is a history course with mathematics as its subject. Includes topics in the history of mathematics from early civilizations onwards. The growth of mathematics, both as an abstract discipline and as a subject which interacts with others and with practical concerns, is explored. Pre- or Co-requisite: MATH 2300 or MATH 2340 and graduate standing.
Credit Hours: 3

MATH 7300: Numerical Analysis
(cross-leveled with MATH 4300). Machine arithmetic, approximation and interpolation, numerical differentiation and integration, nonlinear equations, linear systems, differential equations, error analysis. Selected algorithms will be programmed for solution on computers.
Credit Hours: 3
Prerequisites: graduate standing and MATH 2300 and MATH 4100 or equivalent

MATH 7310: Numerical Linear Algebra
Credit Hours: 3
Prerequisites: MATH 2300 and prior experience writing programs in Mathematica and/or in a computer language such as Fortran, Pascal, or C
Recommended: MATH 4140
MATH 7330: Theory of Numbers
(cross-leveled with MATH 4330). Divisibility, factorization, arithmetic functions, means value theorems, distribution of prime numbers, congruences, primitive roots, character theory, Riemann zeta function, and Dirichlet L-functions.
Credit Hours: 3
Prerequisites: MATH 2300; recommended MATH 2320 or MATH 2340, and MATH 4940 or MATH 7940

MATH 7350: Introduction to Non-Euclidean Geometry
Credit Hours: 3
Prerequisites: MATH 2300

MATH 7355: Mathematics of Financial Derivatives I
(cross-leveled with MATH 4355). Long and short positions, forward contracts, exchange traded index futures, European and American call and put options, put-call parity, trading and hedging strategies, synthetic transactions, arbitrage, currency options, fixed income portfolio management, duration, convexity, interest rate and currency swaps, embedded options.
Credit Hours: 3
Prerequisites: MATH 2300 and STAT 2500 or STAT 4710/ MATH 4315, or instructor's consent

MATH 7370: Interest Theory
(cross-leveled with MATH 4370). This course covers the main probability tools applied to financial risk modeling, and the financial mathematics concepts used in calculating present and accumulated values for various cash flows. It is a useful tool in preparing for the Society of Actuaries exams P (Probability) and FM (Financial Mathematics), and it is oriented towards problem solving techniques illustrated with previous exam problems. Students are encouraged to take MATH 4355 prior to this course.
Credit Hours: 3
Prerequisites: MATH 2300, MATH 4320/ STAT 4750, or instructor's consent

MATH 7371: Models for Life Contingencies I
(cross-leveled with MATH 4371). The sequence MATH 4371 - MATH 4372 is designed to help students prepare for the Society of Actuaries exam LTAM (Long-Term Actuarial Mathematics). This course teaches the basic theory of life contingent actuarial models and the applications of those models to insurance and other financial risks. Covered topics include: survival models, life tables and selection, insurance benefits, life annuities, premium calculation and reserves.
Credit Hours: 3
Prerequisites: MATH 2300 OR MATH 2320

MATH 7372: Models for Life Contingencies II
(cross-leveled with MATH 4372). The sequence MATH 4371 - MATH 4372 is designed to help students prepare for the Society of Actuaries exam LTAM (Long-Term Actuarial Mathematics). This course extends the life-death contingency models of MATH 4371 to more general multiple-state and multiple-life models applied to problems involving a wide range of insurance and pension benefits. Covered topics include: Markov chains, multiple decrement models, joint life and last survivor benefits, pension mathematics, profit testing.
Credit Hours: 3
Prerequisites: A grade of C- or better in MATH 4371 or MATH 7371

MATH 7400: Applied Analysis
Credit Hours: 3
Prerequisites: MATH 2300 OR MATH 2320

MATH 7500: Applied Analysis
Credit Hours: 3
Prerequisites: MATH 2300 OR MATH 2320

MATH 7510: Higher Algebra
(cross-leveled with MATH 4510). Introduction to rings, integral domains, fields, groups.
Credit Hours: 3
Prerequisites: MATH 2300 OR MATH 2320

MATH 7540: Mathematical Modeling I
(cross-leveled with MATH 4540). Solution of problems from industry, physical, social and life sciences, economics, and engineering using mathematical models.
Credit Hours: 3
Prerequisites: graduate standing and 3 semesters of calculus and some exposure to ordinary differential equations or instructor's consent

MATH 7560: Nonlinear Dynamics, Chaos and Fractals
(cross-leveled with MATH 4560). Conceptual introduction to nonlinear dynamics, bifurcation and stability of steady states, chaos in nonlinear differential equations and maps, fractal dimension, strange attractors, and applications to physical science.
Credit Hours: 3
Prerequisites: graduate standing and MATH 4100/ MATH 7100, MATH 4140/ MATH 7140, and familiarity with software such as MATHEMATICA, MATLAB, or MAPLE

MATH 7590: Mathematics of Financial Derivatives II
(cross-leveled with MATH 4590). Binomial and Black-Scholes pricing models. Option Greeks, delta and gamma hedging, market maker profit theory. Asian, barrier, compound, gap and exchange options. Lognormal and Monte Carlo price simulation. Geometric Brownian Motion and Ito's Lemma. Interest rate models and volatility. Prerequisites: MATH 2300 and either STAT 2500 or STAT 4710 or MATH 4315.
Credit Hours: 3
Mathematics (MATH)

Prerequisites: MATH 2300 and either STAT 2500 or STAT 4710 or MATH 4315
Recommended: MATH 4355

MATH 7700: Advanced Calculus of One Real Variable I
(cross-leveled with MATH 4700). Series of real numbers, limits of functions, continuity and uniform continuity, differentiability, and Riemann integration.
Credit Hours: 3
Prerequisites: MATH 2300
Recommended: MATH 4140 and one other mathematics course number above MATH 2300

MATH 7720: Introduction to Abstract Algebra I
(cross-leveled with MATH 4720). Basic properties of integers, fundamental theorem of arithmetic, introduction to groups, rings and fields.
Credit Hours: 3
Prerequisites: MATH 2300
Recommended: MATH 4140 and one other Mathematics course numbered above 2300

MATH 7900: Advanced Multivariable Calculus
(cross-leveled with MATH 4900). This is a course in calculus in several variables. The following is core material: Basic topology of n-dimensional Euclidian space; limits and continuity of functions; the derivative as a linear transformation; Taylor's formula with remainder; the Inverse and Implicit Function Theorems, change of coordinates; integration (including transformation of integrals under changes of coordinates); Green's Theorem. Additional material from the calculus of several variables may be included, such as Lagrange multipliers, differential forms, etc.
Credit Hours: 3
Prerequisites: MATH 4700/ MATH 7700

MATH 7920: Introduction to Abstract Linear Algebra
(cross-leveled with MATH 4920). Study of vector spaces over arbitrary fields: topics include linear maps on finite dimensional vector spaces, bilinear and multi-linear forms, invariant subspaces and canonical forms.
Credit Hours: 3
Prerequisites: MATH 2300

MATH 7940: Introduction to Complex Variables
(cross-leveled with MATH 4940). Complex functions, contour integration, power series, residues and poles, conformal mapping.
Credit Hours: 3
Prerequisites: MATH 4110/ MATH 7110 OR MATH 4700/ MATH 7700

MATH 7960: Special Readings in Mathematics
Credit Hour: 1-3
Prerequisites: MATH 2300 and instructor's consent

MATH 7980: Mathematics Problem Solving
Creative advanced problem solving bringing together methods such as integration, probability and Euclidean geometry.
Credit Hours: 3
Prerequisites: MATH 4140 and another 4000 level Mathematics course, or instructor's consent

MATH 8085: Problems in Mathematics
Problems in Mathematics
Credit Hours: 3

MATH 8090: Master's Thesis Research in Mathematics
Students will be required to complete an independent project. Topics are chosen in consultation with a faculty advisor and are subject to departmental consent. Graded on S/U basis only.
Credit Hours: 3

MATH 8102: Topics in Algebra
Advanced topics in algebra.
Credit Hours: 3
Prerequisites: MATH 8410

MATH 8190: Masters Project in Mathematics
Masters Project in Mathematics
Credit Hours: 3

MATH 8202: Topics in Functional Analysis
Topics in Functional Analysis
Credit Hours: 3
Prerequisites: MATH 4700, MATH 4900, MATH 4940, instructor's consent or equivalent

MATH 8210: Basic Algebra
Accelerated problem solving course in linear and abstract algebra. Will prepare students for the algebra qualifying exam.
Credit Hours: 3
Prerequisites: MATH 4720, MATH 4920, or instructor's consent, or equivalent
Corequisites: MATH 8210 and MATH 8220

MATH 8220: Basic Analysis
Accelerated problem-solving course in advanced calculus and complex analysis. Will prepare students for the analysis qualifying exam.
Credit Hours: 6
Prerequisites: MATH 4700, MATH 4900, MATH 4940, instructor's consent or equivalent

MATH 8250: Basic Topology and Geometry
Credit Hours: 3
Prerequisites: MATH 4700, MATH 4900, MATH 4140, or instructor's consent, or equivalent
Corequisites: MATH 8210 and MATH 8220

MATH 8302: Topics in Harmonic Analysis
Topics in Harmonic Analysis
Credit Hours: 3
MATH 8402: Topics in Mathematical Physics
Topics in Mathematical Physics
Credit Hours: 3

MATH 8410: Algebra I
Theory of algebraic structures--groups, rings, fields, algebraic and transcendental extensions of fields.
Credit Hours: 3
Prerequisites: MATH 4720 and MATH 4920, or equivalent

MATH 8411: Algebra II
Theory of modules, Galois theory and additional topics to be selected by the instructor.
Credit Hours: 3
Prerequisites: MATH 8410 or equivalent

MATH 8420: Theory of Functions of Real Variables I
Properties of functions of one real variable. Lebesgue measure and integration on the line.
Credit Hours: 3
Prerequisites: MATH 4700 or MATH 7700 and MATH 4900 or MATH 7900, or equivalent

MATH 8421: Theory of Functions of Real Variables II
Continuation of MATH 8420. General measure and integration theory. Elements of the theory of Hilbert and Banach spaces, linear functions and linear operators.
Credit Hours: 3
Prerequisites: MATH 8420

MATH 8425: Complex Analysis I
Rigorous introduction to the theory of functions of a complex variable.
Credit Hours: 3
Prerequisites: MATH 4940 or MATH 7940 or equivalent

MATH 8426: Complex Analysis II
Analytic continuation, Riemann surfaces, entire and meromorphic functions, selected topics.
Credit Hours: 3
Prerequisites: MATH 8425

MATH 8440: Advanced Ordinary Differential Equations I
Topics from existence and uniqueness theorems, plane autonomous systems, periodicity and boundedness of solutions of second order nonlinear equations, perturbation theory, Sturm-Liouville systems, behavior of solutions at singularities.
Credit Hours: 3
Prerequisites: MATH 4700 or MATH 7700 or equivalent

MATH 8445: Partial Differential Equations I
Fourier and integral transforms, first and second order partial differential equations, methods of characteristics, Laplace's equation, Dirichlet and Neumann problems, Green's functions and maximum principles.
Credit Hours: 3
Prerequisites: MATH 4700 or MATH 7700 or instructor's consent required

MATH 8446: Partial Differential Equations II
The Cauchy-Kovalevski theorem, the Lewy example, the heat operator, the wave operator, Sobolev spaces, local regularity of elliptic boundary value problems.
Credit Hours: 3
Prerequisites: MATH 8445
Recommended: MATH 8420

MATH 8460: Mathematical Finance I
Credit Hours: 3
Prerequisites: graduate standing in Mathematics. Knowledge of elementary probability or instructor's consent

MATH 8461: Mathematical Finance II
Credit Hours: 3
Prerequisites: knowledge of advance probability/stochastic processes or instructor's consent
Recommended: MATH 8460

MATH 8480: Advanced Probability
(same as STAT 9810). Measure theoretic probability theory. Characteristic functions; conditional probability and expectation; sums of independent random variables including strong law of large numbers and central limit problem.
Credit Hours: 3
Prerequisites: MATH 4320 or MATH 8220; or instructor's consent

MATH 8502: Topics of Geometry
Topics of Geometry.
Credit Hours: 3
Prerequisites: instructor's consent
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Description</th>
<th>Credit Hours</th>
<th>Prerequisites</th>
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<tr>
<td>MATH 8587</td>
<td>Topology Seminar</td>
<td>Topology Seminar</td>
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<tr>
<td>MATH 8615</td>
<td>Algebraic Geometry I</td>
<td>Affine and projective varieties and schemes; nullstellensatz; Zariski topology, morphisms and rational maps; divisors and linear systems; topics from curves, surfaces, Grassmann varieties; commutative algebra and homological algebra as needed.</td>
<td>3</td>
<td>MATH 8410</td>
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<tr>
<td>MATH 8616</td>
<td>Algebraic Geometry II</td>
<td>Continuation of MATH 8615.</td>
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<td>MATH 8615</td>
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<tr>
<td>MATH 8618</td>
<td>Introduction to Algebraic Topology</td>
<td>Development of singular homology theory; reference to other homology and cohomology theories. Introduction to homological algebra.</td>
<td>3</td>
<td>MATH 8250</td>
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<tr>
<td>MATH 8628</td>
<td>Functional Analysis I</td>
<td>Linear topological spaces, Banach spaces, Hilbert spaces. Operator theory, including the Hahn-Banach, uniform boundedness and closed graph theorems.</td>
<td>3</td>
<td>MATH 4900 and instructor's consent or MATH 8420</td>
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<tr>
<td>MATH 8630</td>
<td>Harmonic Analysis I</td>
<td>An introduction to Fourier Analysis in one and higher Dimensions. Topics include Fourier Series, conjugate functions, Fourier transforms, distributions, interpolation, and maximal functions.</td>
<td>3</td>
<td>MATH 8420</td>
</tr>
<tr>
<td>MATH 8631</td>
<td>Harmonic Analysis II</td>
<td>Singular integrals, Littlewood-Paley theory, Hardy spaces, bounded mean oscillation, weighted norm inequalities, boundary value problems, and analysis on groups.</td>
<td>3</td>
<td>MATH 8630</td>
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<tr>
<td>MATH 8650</td>
<td>Differentiable Manifolds and Riemannian Geometry</td>
<td>Tensor product spaces and tensor fields on manifolds. Differentiation and integration of differential forms. Riemannian geometry and applications.</td>
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<td>MATH 4700 or MATH 4400</td>
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<tr>
<td>MATH 8655</td>
<td>General Topology I</td>
<td>Introduction to axiomatic theory of general topology. Continuous functions and homeomorphisms. Convergence in abstract topological spaces.</td>
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<tr>
<td>MATH 8670</td>
<td>Topology Seminar</td>
<td>Topology Seminar</td>
<td>3</td>
<td>MATH 4900, MATH 4400 or instructor's consent</td>
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<tr>
<td>MATH 8702</td>
<td>Topics in Applied Mathematics</td>
<td>Selected topics in applied mathematics drawn from variety of areas: partial differential equations, tensor analysis, calculus of variations, asymptotic methods, integral equations, advanced theory of transforms and distributions, numerical analysis.</td>
<td>3</td>
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<tr>
<td>MATH 9090</td>
<td>Doctoral Dissertation Research in Mathematics</td>
<td>Doctoral Dissertation Research in Mathematics. Graded on a S/U basis only.</td>
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<tr>
<td>MATH 9387</td>
<td>Harmonic Analysis Seminar</td>
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<td>MATH 9487</td>
<td>Mathematical Physics Seminar</td>
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<tr>
<td>MATH 9502</td>
<td>Topics in Topology</td>
<td>Advanced topics in topology or topological algebra.</td>
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<tr>
<td>MATH 9787</td>
<td>Applied Mathematics Seminar</td>
<td>Applied Mathematics Seminar</td>
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<td>MATH 9887</td>
<td>Analysis Seminar</td>
<td>Analysis Seminar</td>
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