MATH - MATHEMATICS

MATH107 Introduction to Math Modeling and Probability (3 Credits)
A goal is to convey the power of mathematics as shown by a variety of problems which can be modeled and solved by quantitative means. Also included is an introduction to probability. Topics include data analysis, equations, systems of equations, inequalities, elementary linear programming, Venn diagrams, counting, basic probability, permutations, combinations, tree diagrams, standard normal and normal distributions. The mathematics of finance is covered. The course includes problem solving and decision making in economics, management, and social sciences.
Prerequisite: Must have math eligibility of MATH107 or higher; and math eligibility is based on Math Placement Exam or successful completion of MATH003 with appropriate eligibility.
Restriction: Not open to students majoring in mathematics, engineering, business, life sciences, and the physical sciences; must not have completed STAT100, MATH113, MATH120, MATH135, MATH136 or MATH140 with a C- or better; must not have completed any MATH or STAT course with a prerequisite of MATH120, MATH136, or MATH140.
Formerly: MATH110 and MATH111.

MATH113 College Algebra and Trigonometry (3 Credits)
Topics include elementary functions including graphs and applications of: polynomial, rational, exponential, and logarithmic functions. Systems of equations and applications. Trigonometric functions: angle and radian measure, graphs and applications.
Prerequisite: Must have math eligibility of MATH113 or higher; and math eligibility is based on the Math Placement Exam or the successful completion of MATH 003 with appropriate eligibility.
Restriction: Must not have completed MATH115, MATH120, MATH135, MATH136 or MATH140 with a grade of C- or higher; and must not have completed any course with a prerequisite of MATH120, MATH130, MATH136, or MATH140.

MATH115 Precalculus (3 Credits)
Preparation for MATH120, MATH135 or MATH140. Elementary functions and graphs: polynomials, rational functions, exponential and logarithmic functions, trigonometric functions. Algebraic techniques preparatory for calculus.
Prerequisite: Must have math eligibility of MATH115 or higher; and math eligibility is based on the Math Placement Exam or the successful completion of MATH003 with appropriate eligibility. Or MATH113.
Restriction: Must not have completed MATH140 with a grade of C- or better; and must not have completed any MATH or STAT course with a prerequisite of MATH140 or MATH141.

MATH120 Elementary Calculus I (3 Credits)
Basic ideas of differential and integral calculus, with emphasis on elementary techniques of differentiation and applications.
Prerequisite: 1 course with a minimum grade of C- from (MATH113, MATH115). Or must have math eligibility of MATH120 or higher; and math eligibility is based on the Math Placement Test.
Restriction: Not open to students majoring in mathematics, engineering, the biological sciences, biochemistry, chemistry, or the physical sciences; Must not have completed MATH130, MATH136 or MATH140 with a grade of C- or higher.
Formerly: MATH220.

MATH121 Elementary Calculus II (3 Credits)
Trigonometric functions, techniques of integration, infinite series, differential equations, probability.
Prerequisite: MATH120, MATH130, MATH136, or MATH140.
Restriction: Not open to students majoring in mathematics, engineering, the biological sciences, biochemistry, chemistry, or the physical sciences; Must not have completed MATH141 with a grade of C- or higher.
Formerly: MATH221.

MATH135 Discrete Mathematics for Life Sciences (4 Credits)
Basic discrete mathematics, with emphasis on relevant models and techniques to the life sciences.
Prerequisite: Minimum grade of C- in MATH113 or MATH115; or must have math eligibility of MATH120 or higher; and math eligibility is based on the Math Placement Test.
Restriction: Must be in the Biological Sciences or Neuroscience major; and not open to students majoring in mathematics, engineering, or the physical sciences.

MATH136 Calculus for Life Sciences (4 Credits)
Continuation of MATH135, including basic ideas of differential and integral calculus, with emphasis on elementary techniques and applications to the life sciences.
Prerequisite: Minimum grade of C- in MATH135.
Restriction: Must be in the Biological Sciences or Neuroscience major; Must not have completed MATH140 with a grade of C- or higher.

MATH140 Calculus I (4 Credits)
Introduction to calculus, including functions, limits, continuity, derivatives and applications of the derivative, sketching of graphs of functions, definite and indefinite integrals, and calculation of area. The course is especially recommended for science, engineering and mathematics majors.
Prerequisite: Minimum grade of C- in MATH115; or must have math eligibility of MATH140; and math eligibility is based on the Math Placement Test.

MATH141 Calculus II (4 Credits)
Continuation of MATH140, including techniques of integration, improper integrals, applications of integration (such as volumes, work, arc length, moments), inverse functions, exponential and logarithmic functions, sequences and series.
Prerequisite: Minimum grade of C- in MATH140.

MATH199 Special Topics in Mathematics (3 Credits)
Many games have a mathematical component. We will introduce several games, play them, and investigate the underlying mathematics. Students will work in teams on projects that involve developing strategies for new games.
Prerequisite: Permission of CMNS-Mathematics department.

MATH206 Introduction to Matlab (1 Credit)
This course is intended to prepare students for subsequent courses requiring computation with MATLAB. Covers basics of MATLAB including simple commands, variables, solving equations, graphing differentiation and integration, matrices and vectors, functions, M-files and fundamentals of programming in the MATLAB environment. When offered in Winter and Summer terms, the course is offered in a format suitable for online distance learning.
Prerequisite: 1 course with a minimum grade of C- from (MATH136, MATH140).

MATH212 Elements of Numbers and Operations (3 Credits)
Reviews and extends topics of arithmetic and number theory related to the elementary school curriculum, particularly number systems and operations with natural numbers, integers, and rationals.
Prerequisite: Must have completed one year of college preparatory algebra.
Restriction: Must be in one of the following programs (Early Childhood Education; Special Education; Elementary Education; Middle School Education).

MATH213 Elements of Geometry and Measurement (3 Credits)
Properties of geometric objects in two and three dimensions; parallel lines, curves and polygons; ratio, proportion, similarity; transformational geometry and measurement, constructions, justifications and proofs.
Prerequisite: MATH212.
Restriction: Must be in one of the following programs (Early Childhood Education; Special Education; Elementary Education; Middle School Education).

MATH214 Elements of Probability and Statistics (3 Credits)
Permutations and combinations; probability; collecting and representing data; using statistics to analyze and interpret data.
Prerequisite: MATH212.
Restriction: Must be in one of the following programs (Early Childhood Education; Special Education; Elementary Education; Middle School Education).

MATH240 Introduction to Linear Algebra (4 Credits)
Basic concepts of linear algebra: vector spaces, applications to line and plane geometry, linear equations and matrices, similar matrices, linear transformations, eigenvalues, determinants and quadratic forms.
Prerequisite: 1 course with a minimum grade of C- from (MATH131, MATH141).
Credit Only Granted for: MATH240, MATH341, or MATH461.

MATH241 Calculus III (4 Credits)
Introduction to multivariable calculus, including vectors and vector-valued functions, partial derivatives and applications of partial derivatives (such as tangent planes and Lagrange multipliers), multiple integrals, volume, surface area, and the classical theorems of Green, Stokes and Gauss.
Prerequisite: Minimum grade of C- in MATH141.
Credit Only Granted for: MATH241 or MATH340.

MATH243 Introduction to Linear Algebra and Differential Equations (4 Credits)
The basics of linear algebra and differential equations, with an emphasis on general physical and engineering applications. Aimed at students who need the material for future coursework but do not need as much depth and rigor as provided by MATH240 and MATH246.
Prerequisite: Minimum grade of C- in MATH141.
Credit Only Granted for: ENEE290 or MATH243.
Additional Information: Does not satisfy requirements for the Mathematics or Computer Science major. Does not satisfy prerequisite requirements for courses requiring MATH240 or MATH246.

MATH246 Differential Equations for Scientists and Engineers (3 Credits)
An introduction to the basic methods of solving ordinary differential equations. Equations of first and second order, linear differential equations, Laplace transforms, numerical methods and the qualitative theory of differential equations.
Prerequisite: Minimum grade of C- in MATH141.
Credit Only Granted for: MATH246 or MATH341.

MATH274 History of Mathematics (3 Credits)
An overview of aspects in the history of mathematics from its beginning in the concrete problem solving of ancient times through the development of abstraction in the 19th and 20th centuries. The course considers both mathematical ideas and the context in which they developed in various civilizations around the world.
Prerequisite: MATH120, MATH130, MATH136, or MATH140; or must have completed MATH220.

MATH299 Selected Topics in Mathematics (1-3 Credits)
Topics of special interest under the general guidance of the departmental committee on undergraduate studies.
Prerequisite: Permission of CMNS-Mathematics department.

MATH310 Introduction to Mathematical Proof (3 Credits)
To develop the students' ability to construct a rigorous proof of a mathematical claim. Students will also be made aware of mathematical results that are of interest to those wishing to analyze a particular mathematical model. Topics will be drawn from logic, set theory, structure of the number line, elementary topology, metric spaces, functions, sequences and continuity.
Prerequisite: Minimum grade of C- in MATH141; and must have completed or be concurrently enrolled in MATH240, MATH341, or MATH461; and must have completed or be concurrently enrolled in MATH241 or MATH340.
Restriction: Must be in a major within the CMNS-Mathematics department; or must be in the Mathematics minor within the CMNS-Mathematics department; or permission of the CMNS-Mathematics department.
Additional Information: Math majors may not use this course to satisfy an upper-level requirement.

MATH312 Mathematical Reasoning and Proof for Pre-Service Middle School Teachers (3 Credits)
Reasoning and proof as addressed in the middle school curriculum. Topics include proportional reasoning, logic and proof, types of numbers, field axioms, Euclidean and non-Euclidean geometry.
Prerequisite: MATH212 and MATH213.
Restriction: Must be in one of the following programs (Elementary Education; Special Education; Middle School Education).

MATH314 Introduction to Probability, Data, Analysis and Statistics for Preservice Middle School Teachers (3 Credits)
Analysis of bivariate data, probability and randomness, law of large numbers, central limit theorem, probabilities for independent and dependent events, counting techniques, random variables and probability distributions, expected values, sampling distributions, and confidence intervals.
Prerequisite: MATH214.
Restriction: Must be in one of the following programs (Elementary Education; Special Education; Middle School Education).

MATH315 Algebra for Preservice Middle School Teachers (3 Credits)
Algebraic concepts and techniques developed in the middle grades, with their larger mathematical context. Equations, inequalities and functions (linear, polynomial, exponential, logarithmic), with multiple representations of relationships. Common misconceptions of beginning algebra students.
Prerequisite: MATH212.
Restriction: Must be in one of the following programs (Elementary Education; Special Education; Middle School Education).

MATH340 Multivariable Calculus, Linear Algebra and Differential Equations I (Honors) (4 Credits)
First semester of the MATH340-341 sequence which gives a unified and enriched treatment of multivariable calculus, linear algebra and ordinary differential equations, with supplementary material from subjects such as differential geometry, Fourier series and calculus of variations. Students completing MATH340-341 will have covered the material of MATH240, MATH241, and MATH246, and may not also receive credit for MATH240, MATH241 or MATH246.
Prerequisite: MATH141 and MATH140; and permission of CMNS-Mathematics department; and permission will be granted only to incoming freshmen.
Credit Only Granted for: MATH241 or MATH340.

MATH341 Multivariable Calculus, Linear Algebra, Differential Equations II (Honors) (4 Credits)
A continuation of MATH340.
Prerequisite: Minimum grade of C- in MATH340 and permission of CMNS-Mathematics department; and permission will be granted only to current freshmen.
Restriction: Open to second semester Freshmen only.
Credit Only Granted for: MATH240, MATH246, MATH341 or MATH461.

MATH386 Experiential Learning (3-6 Credits)
Prerequisite: Must have learning proposal approved by the CMNS Mathematics Department.

MATH401 Applications of Linear Algebra (3 Credits)
Various applications of linear algebra: theory of finite games, linear programming, matrix methods as applied to finite Markov chains, random walk, incidence matrices, graphs and directed graphs, networks and transportation problems.
Prerequisite: 1 course with a minimum grade of C- from (MATH461, MATH240, MATH341).

MATH402 Algebraic Structures (3 Credits)
For students having only limited experience with rigorous mathematical proofs. Parallels MATH403. Students planning graduate work in mathematics should take MATH403. Groups, rings, integral domains and fields, detailed study of several groups; properties of integers and polynomials. Emphasis is on the origin of the mathematical ideas studied and the logical structure of the subject.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH341, MATH461).
Restriction: Must not be in any of the following programs (Mathematics (Master's); Mathematics (Doctoral)).
Credit Only Granted for: MATH402 or MATH403.

MATH403 Introduction to Abstract Algebra (3 Credits)
Integers; groups, rings, integral domains, fields.
Prerequisite: 1 course with a minimum grade of C- from (MATH405 or MATH410).
Credit Only Granted for: MATH402 or MATH403.

MATH404 Field Theory (3 Credits)
Algebraic and transcendental elements, Galois theory, constructions with straight-edge and compass, solutions of equations of low degrees, insolubility of the quintic equation, Sylow theorems, fundamental theorem of finite Abelian groups.
Prerequisite: Minimum grade of C- in MATH403.

MATH405 Linear Algebra (3 Credits)
An abstract treatment of finite dimensional vector spaces. Linear transformations and their invariants.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH461, MATH341); and minimum grade of C- in MATH310.

MATH406 Introduction to Number Theory (3 Credits)
Integers, divisibility, prime numbers, unique factorization, congruences, quadratic reciprocity, Diophantine equations and arithmetic functions.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH241, MATH246, MATH340, MATH341, MATH461, MATH243, ENEE290); or permission of CMNS-Mathematics department.

MATH410 Advanced Calculus I (3 Credits)
Subjects covered: sequences and series of numbers, continuity and differentiability of real-valued functions of one variable, the Riemann integral, sequences of functions and power series.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH461, MATH341); and 1 course with a minimum grade of C- from (MATH340, MATH241); and minimum grade of C- in MATH310; and permission of CMNS-Mathematics department.

MATH411 Advanced Calculus II (3 Credits)
Continuation of MATH410. Topics include: The topology of sets in Rn, the derivative matrix, the general chain rule, inverse and implicit function theorems with applications, smooth curves and surfaces in R3, Lagrange multipliers. Additional topics may include: Metric spaces, the contraction principle, the existence and uniqueness theorem for nonlinear first order differential equations, the Riemann integral of Rn, introduction to integration on curves and surfaces, Green's theorem.
Prerequisite: Minimum grade of C- in MATH410.

MATH416 Applied Harmonic Analysis: An Introduction to Signal Processing (3 Credits)
Introduces students to the mathematical concepts arising in signal analysis from the applied harmonic analysis point of view. Topics include applied linear algebra, Fourier series, discrete Fourier transform, Fourier transform, Shannon Sampling Theorem, wavelet bases, multiresolution analysis, and discrete wavelet transform.
Prerequisite: Minimum grade of C- in MATH141; and 1 course with a minimum grade of C- from (MATH240, MATH461, MATH341); and familiarity with MATLAB is required.

MATH420 Mathematical Modeling (3 Credits)
The course will develop skills in data-driven mathematical modeling through individual and group projects. Emphasis will be placed on both analytical and computational methods, and on effective oral and written presentation of results.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH461, MATH341, ENEE290, MATH243); and 1 course with a minimum grade of C- from (MATH241, MATH340); and 1 course with a minimum grade of C- from (MATH246, MATH341, ENEE290, MATH243); and 1 course with a minimum grade of C- from (STAT400, STAT410); and 1 course with a minimum grade C- from (CMSC106, CMSC131).
Recommended: AMSC460 or AMSC466.
Cross-listed with: AMSC420.
Credit Only Granted for: AMSC420 or MATH420.

MATH423 Linear Optimization (3 Credits)
Mathematical formulation of linear programming, graphical solutions, simplex method, duality, transportation problems, assignment problems, and game theory.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH401, MATH461, or MATH341).
Credit Only Granted for: MATH423 or MATH498T.
Formerly: MATH498T.

MATH424 Introduction to the Mathematics of Finance (3 Credits)
Introduction to the mathematical models used in finance and economics with emphasis on pricing derivative instruments. Designed for students in mathematics, computer science, engineering, finance and physics. Financial markets and instruments; elements from basic probability theory; interest rates and present value analysis; normal distribution of stock returns; option pricing; arbitrage pricing theory; the multiperiod binomial model; the Black-Scholes option pricing formula; proof of the Black-Scholes option pricing formula and applications; trading and hedging of options; Delta hedging; utility functions and portfolio theory; elementary stochastic calculus; Ito's Lemma; the Black-Scholes equation and its conversion to the heat equation.
Prerequisite: Minimum grade of C- in MATH141; and 1 course with a minimum grade of C- from (STAT400, STAT410); and permission of CMNS-Mathematics department.
Recommended: MATH246, MATH240, MATH241, MATH340, or MATH341.
Credit Only Granted for: BMGT444, MATH424.

MATH430 Euclidean and Non-Euclidean Geometries (3 Credits)
Hilbert's axioms for Euclidean geometry. Neutral geometry: the consistency of the hyperbolic parallel postulate and the inconsistency of the elliptic parallel postulate with neutral geometry. Models of hyperbolic geometry. Existence and properties of isometries.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH341, MATH461).

MATH431 Geometry for Computer Applications (3 Credits)
Topics from projective geometry and transformation geometry, emphasizing the two-dimensional representation of three-dimensional objects and objects moving about in the plane and space. The emphasis will be on formulas and algorithms of immediate use in computer graphics.
Prerequisite: 1 course with a minimum grade of C- from (MATH461, MATH240, MATH341).

MATH432 Introduction to Topology (3 Credits)
Metric spaces, topological spaces, connectedness, compactness (including Heine-Borel and Bolzano-Weierstrass theorems), Cantor sets, continuous maps and homeomorphisms, fundamental group (homotopy, covering spaces, the fundamental theorem of algebra, Brouwer fixed point theorem), surfaces (e.g., Euler characteristic, the index of a vector field, hairy sphere theorem), elements of combinatorial topology (graphs and trees, planarity, coloring problems).
Prerequisite: Minimum grade of C- in MATH410.

MATH436 Differential Geometry of Curves and Surfaces I (3 Credits)
Curves in the plane and Euclidean space, moving frames, surfaces in Euclidean space, orientability of surfaces; Gaussian and mean curvatures; surfaces of revolution, ruled surfaces, minimal surfaces, special curves on surfaces, "Theorema Egregium"; the intrinsic geometry of surfaces.
Prerequisite: 1 course with a minimum grade of C- from (MATH241, MATH340); and 1 course with a minimum grade of C- from (MATH461, MATH240, MATH341); and must have completed two 400-level MATH courses with a minimum grade of C- (not including MATH461, and 480's).

MATH437 Differential Forms (3 Credits)
Introduction to differential forms and their applications, and unites the fundamental theorems of multivariable calculus in a general Stokes Theorem that is valid in great generality. It develops this theory and technique to perform calculations in analysis and geometry. Topics include an introduction to topological spaces, the Gauss-Bonnet Theorem, Gauss's formula for the linking number, and the Cauchy Integral Theorem. Applications include Maxwell's equations of electromagnetism, connections and gauge theory, and symplectic geometry and Hamiltonian dynamics.
Prerequisite: 1 course with a minimum grade of C- from (MATH241, MATH340); and 1 course with a minimum grade of C- from (MATH240, MATH341, MATH461).
Recommended: MATH405, MATH403, MATH436, MATH410, or MATH432.

MATH440 Geometry and Data Science of Sports Analytics (3 Credits)
Students will learn as well as gain hands-on experience in geometrical aspects and data analysis aspects of sports performance analytics. The course will involve programming via Python as well as other software. Topics may include JSON, using API to gather and analyze big data sets arising in sports analytics, detecting geometrical patterns in data, analyzing motion tracking data. Interactions between mathematics, statistics, hands-on programming and geometry of data sets will be emphasized.
Prerequisite: MATH240, MATH341 or MATH461.
Recommended: Python programming experience.
Credit Only Granted for: MATH498R or MATH440.
Formerly: MATH498R.

MATH445 Elementary Mathematical Logic (3 Credits)
Elementary development of propositional and predicate logic, including semantics and deductive systems and with a discussion of completeness, incompleteness and the decision problem.
Prerequisite: Minimum grade of C- in MATH141.

MATH446 Axiomatic Set Theory (3 Credits)
Development of a system of axiomatic set theory, choice principles, induction principles, ordinal arithmetic including discussion of cancellation laws, divisibility, canonical expansions, cardinal arithmetic including connections with the axiom of choice, Hartog's theorem, Konig's theorem, properties of regular, singular and inaccessible cardinals.
Prerequisite: 1 course with a minimum grade of C- from (MATH403, MATH410).

MATH452 Introduction to Dynamics and Chaos (3 Credits)
An introduction to mathematical dynamics and chaos. Orbits, bifurcations, Cantor sets and horseshoes, symbolic dynamics, fractal dimension, notions of stability, flows and chaos. Includes motivation and historical perspectives, as well as examples of fundamental maps studied in dynamics and applications of dynamics.
Prerequisite: MATH341; or MATH246 and one of (MATH240 or MATH461).
Cross-listed with: AMSC452.
Credit Only Granted for: AMSC452 or MATH452.

MATH456 Cryptography (3 Credits)
The theory, application, and implementation of mathematical techniques used to secure modern communications. Topics include symmetric and public-key encryption, message integrity, hash functions, block-cipher design and analysis, number theory, and digital signatures.
Prerequisite: (CMSC106, CMSC131, or ENEE150; or equivalent programming experience); and (2 courses from (CMSC330, CMSC351, ENEE324, or ENEE382); or any one of these courses and a 400-level MATH course, or two 400-level MATH courses); and Permission of CMNS-Mathematics department or permission of instructor.
Cross-listed with: CMSC456, ENEE456.
Credit Only Granted for: MATH456, CMSC456 or ENEE456.

MATH461 Linear Algebra for Scientists and Engineers (3 Credits)
Basic concepts of linear algebra. This course is similar to MATH240, but with more extensive coverage of the topics needed in applied linear algebra: change of basis, complex eigenvalues, diagonalization, the Jordan canonical form.
Prerequisite: Minimum grade of C- in MATH141.
Credit Only Granted for: MATH240, MATH341, or MATH461.
Additional Information: This course may not be used towards the upper level math requirements for MATH/STAT majors.

MATH462 Partial Differential Equations (3 Credits)
Linear spaces and operators, orthogonality, Sturm-Liouville problems and eigenfunction expansions for ordinary differential equations. Introduction to partial differential equations, including the heat equation, wave equation and Laplace's equation. Boundary value problems, initial value problems and initial-boundary value problems.
Prerequisite: 1 course with a minimum grade of C- from (MATH241, MATH340); and 1 course with a minimum grade of C- from (MATH246, MATH341, ENEE290, MATH243).

MATH463 Complex Variables (3 Credits)
The algebra of complex numbers, analytic functions, mapping properties of the elementary functions. Cauchy integral formula. Theory of residues and application to evaluation of integrals. Conformal mapping.
Prerequisite: 1 course with a minimum grade of C- from (MATH241, MATH340).

MATH464 Transform Methods (3 Credits)
Fourier transform, Fourier series, discrete fast Fourier transform (DFT and FFT). Laplace transform. Poisson summations, and sampling. Optional Topics: Distributions and operational calculus, PDEs, Wavelet transform, Radon transform and applications such as Imaging, Speech Processing, PDEs of Mathematical Physics, Communications, Inverse Problems.
Prerequisite: 1 course with a minimum grade of C- from (MATH246, MATH341, ENEE290, MATH243).

MATH470 Mathematics for Secondary Education (3 Credits)
An advanced perspective on some of the core mathematics underlying high school mathematics courses. Topics include number systems, functions of one variable, equations, inequalities, trigonometric functions, curve fitting, and polynomials. The course includes an analysis of alternate approaches to mathematical ideas and problems, and makes connections between ideas that may have been studied separately in different high school and college courses.
Prerequisite: MATH141 and MATH140; and must have completed one 400-level MATH course (not to include MATH461, 478, and 480's).
Restriction: Must be in the Secondary Math Education major.

MATH475 Combinatorics and Graph Theory (3 Credits)
General enumeration methods, difference equations, generating functions. Elements of graph theory, matrix representations of graphs, applications of graph theory to transport networks, matching theory and graphical algorithms.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, MATH341, MATH461, ENEE290, MATH243); and 1 course with a minimum grade of C- from (MATH241, MATH340); and 1 course with a minimum grade of C- from (MATH310, CMSC250).
Cross-listed with: CMSC475.
Credit Only Granted for: MATH475 or CMSC475.

MATH478 Selected Topics For Teachers of Mathematics (1-3 Credits)
Prerequisite: Permission of CMNS-Mathematics department.
Additional Information: Math majors may not use this course to fulfill the upper-level math requirement.

MATH480 Algebra for Middle School Teachers (3 Credits)
Prepares teachers with elementary certification to teach Algebra 1 in middle school. Focuses on basic algebra concepts and related theoretical ideas.
Prerequisite: MATH214.
Restriction: Must be a middle school teacher; and permission of CMNS-Mathematics department.
Credit Only Granted for: MATH480 or MATH483.
Additional Information: Not applicable to MATH/STAT major or minor requirements.

MATH481 Statistics and Data Analysis for Middle School Teachers (3 Credits)
Prepares teachers with elementary certification to teach simple data analysis and probability in middle school. Focuses on understanding basic statistics, data analysis, and related theoretical ideas.
Prerequisite: MATH214.
Restriction: Must be a middle school teacher; and permission of CMNS-Mathematics department.
Credit Only Granted for: MATH481 or MATH485.
Additional Information: Not applicable to MATH/STAT major or minor requirements.

MATH484 Geometry for High School Teachers (3 Credits)
Focuses on concepts related to geometry, including several geometry axiom schemes, transformations, and similarity. Includes constructions with Geometer's Sketchpad.
Prerequisite: MATH141; or students who have taken courses with comparable content may contact the department.
Restriction: Senior standing.
Credit Only Granted for: MATH482, MATH484, or MATH498E.
Formerly: MATH498E.

MATH487 Number for Middle Grades Teachers (3 Credits)
The rational number and proportional reasoning concepts developed in the middle grades and the larger mathematical context for these. Multiple representations of relationships, including verbal descriptions, diagrams, tables, graphs, and equations. Common misconceptions.
Prerequisite: Must have admission to M.A. or M.Ed. with concentration in Mathematics Education; or permission of CMNS-Mathematics department.
Restriction: This course may not be used towards the upper level math requirements for the MATH/STAT major.
Credit Only Granted for: MATH487 or MATH498K.
Formerly: MATH498K.

MATH489 Research Interactions in Mathematics (1-3 Credits)
Students participate in a vertically integrated (undergraduate, graduate and/or postdoctoral, faculty) mathematics research group. Format varies. Students and supervising faculty will agree to a contract which must be approved by the department. Up to three credits of MATH489 may be applied to the mathematics degree requirements. See the department's MATH489 online syllabus for further information.
Prerequisite: Permission of CMNS-Mathematics department.
Repeatable to: 10 credits if content differs.

MATH498 Selected Topics in Mathematics (1-9 Credits)
Topics of special interest to advanced undergraduate students will be offered occasionally under the general guidance of the departmental committee on undergraduate studies.
Repeatable to: 9 credits if content differs.