

MATHEMATICS (MA-UY)

MA-UY 1 Pre-college Math (0 Credits)

Typically offered Summer term

This course reviews trigonometry, quadratic and absolute value questions and inequalities, limits and differentiation of both algebraic and trigonometric functions.

Grading: Ugrd Tandon Pass/Fail

Repeatable for additional credit: No

MA-UY 143 Introduction to Number Theory (3 Credits)

This course covers properties of integers and prime numbers. Congruences. Theorems of Fermat, Euler and Wilson. Quadratic residues. Diophantine equations. | Prerequisite: MA-UY 1124 or equivalent.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA 1124 or equivalent.

MA-UY 202 ANALYSIS II (3 Credits)

Description: This course covers the study of basic topics in analysis with emphasis on methods. The Riemann integral, line integrals, improper integrals, integrals with parameters, transformations, Riemann-Stieltjes integral, uniform and absolute convergence of integrals, sequences, series, uniform convergence, Beta and Gamma functions. | Prerequisites: MA-UY 4613

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 212 Analysis II (3 Credits)

This course covers the study of basic topics in analysis with emphasis on methods. Sequences, series, functions, uniform convergence, continuity, partial differentiation, extreme value problems with constraints, Riemann integrals, line integrals, improper integrals, integrals with parameters, transformations, Riemann-Stieltjes integral, uniform and absolute convergence of integrals. Beta and Gamma functions. | MA 4613

Prerequisites: MA 2122 and MA 2132. MA 4623 prerequisite: MA 4613.

Note: This course is required for MA minors.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 217 Applied Complex Variables (4 Credits)

A first course in complex analysis, with a focus on applications. Topics to be covered include the complex plane, analytic functions, complex differentiation, the Cauchy-Riemann equations, branch cuts, contour integration, the residue theorem, conformal mapping, applications to potential theory and fluid flow. Note: Not open to students who have taken MA-UY 3113. | (MA-UY 2114 or MA-UY 2514) and (MA-UY 2034 or MA-UY 3034 or MA-UY 3044 or MA-UY 3054)

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 223 Introduction to Probability (3 Credits)

Typically offered occasionally

Standard first course in probability, recommended for those planning further work in probability or statistics. Probability of events, random variables and expectations, discrete and continuous distributions, joint and conditional distributions, moment generating functions, the central limit theorem. | Prerequisites: MA-UY 109, MA-UY 2112, MA-UY 2114 OR MA-UY 2514. Note: Not open to students who have taken MA-UY 2224 or MA-UY 3012 or MA-UY 3022.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 109, MA-UY 2112, MA-UY 2114 OR MA-UY 2514.

MA-UY 224 Applied Statistics (4 Credits)

An introduction to the mathematical foundations and techniques of modern statistical analysis for the interpretation of data in the quantitative sciences. Mathematical theory of sampling; normal populations and distributions; chi-square, t, and F distributions; hypothesis testing; estimation; confidence intervals; sequential analysis; correlation, regression; analysis of variance. Applications to the sciences. Use of Matlab for doing computations of the statistical measures listed above. | Prerequisite: MA-UY 3014 or MA-UY 2233 or MA-UY 3514

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA 3012.

MA-UY 231 Statistical Methods (3 Credits)

This course covers analysis of variance with simple experimental designs. Topics covered: Sampling procedures, including sequential analysis. Nonparametric statistical methods. Statistical decisions. | Prerequisite: MA-UY 4113.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA 4113.

MA-UY 492X INDEPENDENT STUDY (1-4 Credits)

Typically offered Fall and Spring

In this course, students read, study and investigate selected topics in mathematics. Students discuss and present problems. | Prerequisite: departmental adviser's approval.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: Yes

MA-UY 902 Introduction to Pre-calculus (2 Credits)

Typically offered occasionally

This course covers foundations of Algebra: exponents, multiplication of algebraic expressions, factoring algebraic expressions, working with algebraic fractions, proportionality, rates of change, equation of a line, completing squares, the quadratic formula, solving equations, system of linear equations, inequalities, domain and range of functions. | Prerequisite: placement exam. Note: credit for this course may not be used to satisfy the minimum credit requirement for graduation.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 912 Pre-calculus A (2 Credits)

Typically offered occasionally

This course covers exponential and logarithmic functions, transformations of functions; trigonometric functions. | Prerequisite: MA-UY 902. Note: credit for this course may not be used to satisfy the minimum credit requirement for graduation.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 902 with a Minimum Grade of C.

MA-UY 914 Precalculus for Engineers (4 Credits)*Typically offered Fall, Spring, and Summer terms*

This course covers: foundations of algebra, exponents, multiplication of algebraic expressions, factoring algebraic expressions, working with algebraic fractions, proportionality, rates of change, equations of lines, completing squares, the quadratic formula, solving equations, systems of linear equations, inequalities, domain and range of functions, exponential and logarithmic functions, compositions of functions, transformations of functions, right triangles, trigonometry of triangles. | Prerequisite: placement exam. Note: credit for this course may not be used to satisfy the minimum credit requirement for graduation. Corequisite: EX-UY 1

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** placement exam.**Corequisites:** EX-UY 1.**MA-UY 954 PRECALCULUS (4 Credits)***Typically offered Fall, Spring, and Summer terms*

This course covers the fundamentals of algebra with a focus on Management and the Life Sciences. The topics include: foundations of algebra, solving equations, exponents, working with algebraic expressions, working with algebraic fractions, proportionality, rates of change, lines in the plane, completing squares, the quadratic formula, systems of linear equations, inequalities, graphs, exponentials, logarithms, inverses of functions, compositions of functions, transformations of functions, and right angle trigonometry. | Prerequisite: placement exam. Note: Course required only for specific Majors in place of MA 914. Credit for this course may not be used to satisfy the minimum credit requirement for graduation. Corequisite: EX-UY 1

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** placement exam.**Corequisites:** EX-UY 1.**MA-UY 1002 The Art of Mathematics (2 Credits)***Typically offered Fall*

This is an introductory course about Mathematics. Areas of Mathematics. History of Mathematics. Mathematical Methods. Great Mathematicians. Famous open and solved mathematical problems. The Study of Mathematics. Mathematical Software. | Prerequisite: Only first-year students are permitted to enroll in this introductory level course.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 1022 CALCULUS 1B (2 Credits)**

In this course the foundations of calculus are studied by investigating functions and their rates of change. Building on a previous knowledge of limits and derivatives, the derivative is studied in more depth with an emphasis on applications and modeling in science and engineering. Applications include rates and related rates, optimization, modeling, and indeterminate forms. The definite integral is introduced as a measure of the total accumulation of a function over an interval, and the course concludes with a study of the Fundamental Theorem of Calculus which links differentiation and integration. | Prerequisite(s): AP credit or MA-UY 1012 or MA-UY 1054. | Corequisite(s): EX-UY 1

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** AP Credit or MA-UY 1012 or MA-UY 1054 | Co-requisite: EX-UY 1.**MA-UY 1024 Calculus I for Engineers (4 Credits)***Typically offered Fall, Spring, and Summer terms*

This course covers: Library of Functions, functions of one variable. Limits, derivatives of functions defined by graphs, tables and formulas, differentiation rules for power, polynomial, exponential and logarithmic functions, derivatives of trigonometric functions, the product and quotient rules, the chain rule, applications of the chain rule, maxima and minima, optimization. The definite integral, the Fundamental Theorem of Calculus and interpretations, theorems about definite integrals, anti-derivatives. MA-UY 1324 is for students who wish to take MA-UY 1024 but need more review of precalculus. MA-UY 1324 covers the same material as MA-UY 1024 but with more contact hours per week, incorporating a full discussion of the required precalculus topics. | Prerequisite: Placement Exam or MA-UY 912 or MA-UY 914, Corequisite: EX-UY 1

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** Placement Exam or MA-UY 912 or MA-UY 914, Corequisite: EX-UY 1.**MA-UY 1044 Linear Algebra (4 Credits)***Typically offered Fall and Spring*

Systems of linear equations, Gaussian elimination, matrices, determinants, Cramer's rule. Vectors, vector spaces, basis and dimension, linear transformations. Eigenvalues, eigenvectors, and quadratic forms. Restricted to Tandon math and CS majors and students with a permission code from the math department. Fulfills linear algebra requirement for the BS Math and BS CS degrees. Note: Not open to students who have already taken MA-UY 1533, MA-UY 2034, MA-UY 3113 or MA-UY 3054. | Prerequisite: A grade of C or better in MA-UY 1022 or MA-UY 1024 or MA-UY 1324 or MATH-UH 1012Q or MATH-UH 1013Q or MATH-SHU 121 or MATH-SHU 201

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 1054 Calculus I with Pre-calculus (4 Credits)***Typically offered Fall, Spring, and Summer terms*

This course covers limits, definition of the derivative, differentiation rules for polynomial and trigonometric functions, applications of the chain rule and introduction to optimization with a focus on Management and the Life Sciences. | Prerequisite: Placement exam or MA-UY 912 or MA-UY 954 or equivalent. Note: Course required only for specific Majors in place of MA-UY 1024/1324. Corequisite: EX-UY 1.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** Placement exam or MA-UY 912 or MA-UY 954 or equivalent.**Corequisites:** EX-UY 1.

MA-UY 1114 MATHEMATICS FOR LIBERAL STUDIES (4 Credits)

This course covers Management Science: Euler Circuits, Hamiltonian Circuits, Traveling Salesman Problem, Scheduling Tasks; Coding Information; Zip Codes, Bar Codes, Binary Codes, Cryptography; Social Choice and Decision Making:- Elections with only two alternatives, three or more alternatives, weighted voting systems; Fair Division: The Adjusted Winner Divorce Procedure, Cake-Division schemes; and Consumer Finance Models: Models for savings, arithmetic and geometric growth, compound interest, the number e . | Note: this course applies only to the LS degree. Credit for this course may not be used to satisfy the minimum credit requirement for graduation.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: (EN-UY 1013W OR EXPOS-UA 1 OR EXPOS-UA 4) AND (HUSS-UY 1023W OR EXPOS-UA 2 with a Minimum Grade of D OR EXPOS-UA 9).

MA-UY 1124 Calculus II for Engineers (4 Credits)

Typically offered Fall, Spring, and Summer terms

This course covers techniques of integration, introduction to ordinary differential equations, improper integrals, numerical methods of integration, applications of integration, sequences, series, power series, approximations of functions via Taylor polynomials, Taylor series, functions of two variables, graphs of functions of two variables, contour diagrams, linear functions, functions of three variables. MA-UY 1424 is for students who wish to take MA-UY 1124 but need more review of precalculus. MA-UY 1424 covers the same material as MA-UY 1124 but with more contact hours per week, incorporating a full discussion of the required precalculus topics. | Prerequisites: MA-UY 1024 or MA-UY 1324 | Corequisite: EX-UY 1.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 1132 Numerical Methods for Calculus (2 Credits)

Typically offered Fall and Spring

Functions of Two Variables, and their Graphs. Contour Diagrams. Linear Functions and Functions of Three Variables. Limits and Continuity of functions of two and three variables. Areas and Volumes. Basic Integration methods and Numerical Methods for Definite Integrals. Improper Integrals. Convergence of Series. Power Series. Taylor Polynomial and series. Applications. | Prerequisite: AP credit or transfer credit for Calculus I and II or MA-UY 1112 or (MA-UY 1054 and MA-UY 1154) | Corequisite: EX-UY 1.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: AP credit or transfer credit for Calculus I and II or MA-UY 1112 or (MA-UY 1054 and MA-UY 1154).

Corequisites: EX-UY 1.

MA-UY 1154 Calculus II with Pre-calculus (4 Credits)

Typically offered Fall, Spring, and Summer terms

This course covers the first and second derivatives, optimization problems, antiderivatives, Fundamental Theorem of Calculus, techniques of integration, logarithmic and exponential functions, numerical methods of integration, applications of integration, introduction to differential equations, and introduction to series with a focus on Management and the Life Sciences. | Prerequisite: MA-UY 1054. Note: Course required only for specific Majors in place of MA-UY 1124/1424. Corequisite: EX-UY 1

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 1054.

Corequisites: EX-UY 1.

MA-UY 1252 CALCULUS FOR BUSINESS AND LIFE SCIENCES IIA (2 Credits)

Typically offered Fall, Spring, and Summer terms

This course covers antidifferentiation, the definite integral, integration by substitution, The Fundamental Theorem of Calculus, Area between curves, average value, integration by parts, introduction to differential equations, improper integrals, numerical integration. | Prerequisite: MA-UY 1054. Note: Course required only for specific Majors. Corequisite: EX-UY 1

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 1054.

Corequisites: EX-UY 1.

MA-UY 1324 Integrated Calculus I for Engineers (4 Credits)

Typically offered Fall, Spring, and Summer terms

This course covers: Library of Functions, functions of one variable. Limits, derivatives of functions defined by graphs, tables and formulas, differentiation rules for power, polynomial, exponential and logarithmic functions, derivatives of trigonometric functions, the product and quotient rules, the chain rule, applications of the chain rule, maxima and minima, optimization. The definite integral, the Fundamental Theorem of Calculus and interpretations, theorems about definite integrals, anti-derivatives. MA-UY 1324 is for students who wish to take MA-UY 1024 but need more review of precalculus. MA-UY 1324 covers the same material as MA-UY 1024 but with more contact hours per week, incorporating a full discussion of the required precalculus topics. | Prerequisite: Placement Exam or MA-UY 912 or MA-UY 914. Corequisite: EX-UY 1.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: Placement Exam or MA-UY 0912 or MA-UY 0914.

Corequisites: EX-UY 1.

MA-UY 1424 Integrated Calculus II for Engineers (4 Credits)

Typically offered Fall, Spring, and Summer terms

This course MA-UY 1424 is for students who wish to take MA-UY 1124 but need more review of precalculus. MA-UY 1424 covers the same material as MA-UY 1124 but with more contact hours a week, incorporating a full discussion of the required precalculus topics. | Prerequisites: MA-UY 1022 or MA-UY 1024 or MA-UY 1324. Note: credit for this course may be used to satisfy the minimum credit requirement for graduation. Corequisite: EX-UY 1

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Corequisites: EX-UY 1.

MA-UY 2012 ELEMENTS OF LINEAR ALGEBRA I (2 Credits)

Typically offered all terms

This course introduces vector concepts. Linear transformations. Matrices and Determinants. Characteristic roots and eigenfunctions. | Prerequisite: MA-UY 1124 or equivalent.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: (MA-UY 1124 with a Minimum Grade of D OR MA-UY 1154 with a Minimum Grade of D OR MA-UY 1424 with a Minimum Grade of D OR MA-UY 1252 with a Minimum Grade of D OR Poly Math Placement Test Math Placement = 2012).

MA-UY 2034 Linear Algebra and Differential Equations (4 Credits)*Typically offered Fall, Spring, and Summer terms*

MA-UY 2034 is an introduction to ordinary differential equations and linear algebra. The course develops the techniques for the analytic and numeric solutions of ordinary differential equations (and systems) that are widely used in modern engineering and science. Linear algebra is used as a tool for solving systems of linear equations as well as for understanding the structure of solutions to linear (systems) of differential equations. Topics covered include the fundamental concepts of linear algebra such as Gaussian elimination, matrix theory, linear transformations, vector spaces, subspaces, basis, eigenvectors, eigenvalues and the diagonalization of matrices, as well as the techniques for the analytic and numeric solutions of ordinary differential equations (and systems) that commonly appear in modern engineering and science. | Prerequisite: MA-UY 1124, MA-UY 1424 or MA-UY 1132.

Note: Not open to students who have taken MA-UY 3044 or MA-UY 3054 or MA-UY 3083 or MA-UY 4204.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 1124, MA-UY 1424, or MA-UY 1132, Anti-Requisite: MA-UY 3044 or MA-UY 3054 or MA-UY 4204.

MA-UY 2034G Linear Algebra and Differential Equations (4 Credits)

MA-UY 2034 is an introduction to ordinary differential equations and linear algebra. The course develops the techniques for the analytic and numeric solutions of ordinary differential equations (and systems) that are widely used in modern engineering and science. Linear algebra is used as a tool for solving systems of linear equations as well as for understanding the structure of solutions to linear (systems) of differential equations. Topics covered include the fundamental concepts of linear algebra such as Gaussian elimination, matrix theory, linear transformations, vector spaces, subspaces, basis, eigenvectors, eigenvalues and the diagonalization of matrices, as well as the techniques for the analytic and numeric solutions of ordinary differential equations (and systems) that commonly appear in modern engineering and science. | Prerequisite: MA-UY 1124, MA-UY 1424 or MA-UY 1132.

Note: Not open to students who have taken MA-UY 3044 or MA-UY 3054 or MA-UY 3083 or MA-UY 4204.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 1124, MA-UY 1424, or MA-UY 1132, Anti-Requisite: MA-UY 3044 or MA-UY 3054 or MA-UY 4204.

MA-UY 2054 Applied Business Data Analysis I (4 Credits)*Typically offered Spring*

This course covers applications of theories of random phenomena to problems in business management. Topics include probability theory, discrete and continuous probability distributions, sampling, measures of central value and dispersion, sampling distributions, statistical estimation and introduction to hypothesis testing. Use of statistical software is integrated with the previous topics; examples are drawn from problems in business decision-making. Applications to advanced statistical applications in business management. Emphasis is on application of concepts. Use of statistical software integrated with the previous topics. | Prerequisite: MA-UY 1054 or equivalent. Note: Course required only for Management Majors. Credit for this course may not be used to satisfy the requirements for other majors.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA 1054 or equivalent.

MA-UY 2112 Multivariable Calculus A (2 Credits)*Typically offered occasionally*

This course introduces Multivariable Calculus. Analysis of functions of several variables, vector valued functions, partial derivatives and multiple integrals. | Prerequisite: MA-UY 2012.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 2012 with a Minimum Grade of D AND (MA-UY 1124 OR MA-UY 1424).

MA-UY 2114 Calculus III: Multi-Dimensional Calculus (4 Credits)*Typically offered Fall, Spring, and Summer terms*

Vectors in the plane and space. Partial derivatives with applications, especially Lagrange multipliers. Double and triple integrals. Spherical and cylindrical coordinates. Surface and line integrals. Divergence, gradient, and curl. Theorems of Gauss and Stokes. | Prerequisite: MA-UY 1124 or MA-UY 1424 or MA-UY 1132. Anti-requisite: MA-UY 2514

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 1124, MA-UY 1424, or MA-UY 1132.

MA-UY 2122 Multivariable Calculus B (2 Credits)*Typically offered Fall, Spring, and Summer terms*

This course continues Multivariable Calculus. Optimization techniques, parametric equations, line integrals, surface integrals and major theorems concerning their applications. | Prerequisite: MA-UY 2112.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 2112).

Corequisites: (MA-UY 2112 with a Minimum Grade of D OR.

MA-UY 2132 Ordinary Differential Equations (2 Credits)*Typically offered all terms*

This course covers first order differential equations: modeling and solving. Stability of autonomous equations. Higher order linear ordinary differential equations: Solution bases, Wronskian and initial value problems. Linear system of first-order differential equations with constant coefficients: Elimination and eigenvalue method of solution. Elementary concepts of numerical analysis. Numerical solution of initial value problems for ordinary differential equations. | Prerequisite or Corequisite: MA-UY 2012.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 2012 with a Minimum Grade of D).

Corequisites: (MA-UY 2012 OR.

MA-UY 2212 Data Analysis I (2 Credits)*Typically offered Fall, Spring, and Summer terms*

This course covers basic theory of probability. Random variables. Distributions. Expectation. Functions of a random variable. Descriptive statistics. Data description. Sampling distributions. Use of statistical software is integrated with previous topics. | Prerequisite: MA-UY 1124 or equivalent.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: (MA-UY 1122 with a Minimum Grade of D OR MA-UY 1422 with a Minimum Grade of D OR MA-UY 1132 with a Minimum Grade of D OR MA-UY 1124 with a Minimum Grade of D OR MA-UY 1424 with a Minimum Grade of D OR MA-UY 1154 with a Minimum Grade of D).

MA-UY 2222 Data Analysis II (2 Credits)*Typically offered Fall, Spring, and Summer terms*

This course covers point and interval estimation. Hypothesis testing. Linear regression. One-way analysis of variance. Use of statistical software is integrated with the previous topics. | Prerequisite: MA-UY 2212.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 2212).**Corequisites:** (MA-UY 2212 OR.**MA-UY 2224 Data Analysis (4 Credits)***Typically offered Fall, Spring, and Summer terms*

An introductory course to probability and statistics. It affords the student some acquaintance with both probability and statistics in a single term. Topics in Probability include mathematical treatment of chance; combinatorics; binomial, Poisson, and Gaussian distributions; the Central Limit Theorem and the normal approximation. Topics in Statistics include sampling distributions of sample mean and sample variance; normal, t, and Chi-square distributions; confidence intervals; testing of hypotheses; least squares regression model. Applications to scientific, industrial, and financial data are integrated into the course. NOTE: Not open to math majors or students who have taken or will take MA-UY 2054 or MA-UY 3014 or MA-UY 3514 or ECE-UY 2233. | Prerequisite: MA-UY 1124, MA-UY 1424, or MA-UY 1132 or MATH-UH 1020 or MATH-UH 1021 or MATH-SHU 151

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No

Prerequisites: MA-UY 1124, MA-UY 1424, or MA-UY 1132, or MATH-UH 1020 or MATH-UH 1021 or MATH-SHU 151 Anti-Requisites: Not open to math majors or students who have taken or will take MA-UY 2054 or MA-UY 3014 or MA-UY 3514 or ECE-UY 2233.

MA-UY 2233 Introduction to Probability (3 Credits)*Typically offered Fall*

Standard first course in probability, recommended for those planning further work in probability or statistics. Probability of events, random variables and expectations, discrete and continuous distributions, joint and conditional distributions, moment generating functions, the central limit theorem. | Prerequisites: MA-UY 109, MA-UY 2112, MA-UY 2114 OR MA-UY 2514. Note: Not open to students who have taken MA-UY 2224 or MA-UY 3012 or MA-UY 3022.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 109, MA-UY 2112, MA-UY 2114 OR MA-UY 2514.**MA-UY 2312 DISCRETE MATH 1 (2 Credits)***Typically offered Fall and Spring*

This course covers logic and induction. Sets and functions. Recursive definitions. Counting techniques. Inclusion-exclusion principle. |

Prerequisite: MA-UY 1124 or equivalent.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 1124 with a Minimum Grade of D.**MA-UY 2314 Discrete Mathematics (4 Credits)***Typically offered Fall and Spring*

Logic, proofs, set theory, functions, relations, asymptotic notation, recurrences, modeling computation, graph theory. | Prerequisite: Math Diagnostic Exam or MA-UY 912 or MA-UY 914 (minimum calculus level required) | Prerequisite for Shanghai students: MATH-SHU 110. Note: This course and CS-GY 6003 cannot both be taken for credit.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No

Prerequisites: Math Diagnostic Exam or MA-UY 912 or MA-UY 914 (minimum calculus level required) | Prerequisite for Shanghai students: MATH-SHU 110.

MA-UY 2314G Discrete Mathematics (4 Credits)

Logic, proofs, set theory, functions, relations, asymptotic notation, recurrences, modeling computation, graph theory. | Prerequisite: Math Diagnostic Exam or MA-UY 912 or MA-UY 914 (minimum calculus level required) | Prerequisite for Shanghai students: MATH-SHU 110. Note: This course and CS-GY 6003 cannot both be taken for credit.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No

Prerequisites: Math Diagnostic Exam or MA-UY 912 or MA-UY 914 (minimum calculus level required) | Prerequisite for Shanghai students: MATH-SHU 110.

MA-UY 2322 DISCRETE MATH 2 (2 Credits)*Typically offered Fall and Spring*

This course covers recurrence relations and generating functions. Equivalence relations and partial orderings. Graphs and connectivity of graphs. Trees and sorting. Boolean algebra, languages and finite state machines. | Prerequisite: MA-UY 2312.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Corequisites:** MA-UY 2312 with a Minimum Grade of D.**MA-UY 2393 MATHEMATICAL MODELING (3 Credits)**

The construction of a mathematical model. Simple examples. Discrete and continuous models. Deterministic and probabilistic models. Linear and nonlinear models. Detailed examples from engineering disciplines. Testing the validity of a model. | Prerequisites: MA-UY 4423. Note: Not open to students who have taken MA-UY 4444.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 2414 Basic Practice of Statistics for Social Science (4 Credits)***Typically offered Spring*

We are inundated by data, but data alone do not translate into useful information. Statistics provides the means for organizing, summarizing, and therefore better analyzing data so that we can understand what the data tell us about critical questions. If one collects data then understanding how to use statistical methods is critical, but it is also necessary to understand and interpret all the information we consume on a daily basis. This course provides these basic statistical approaches and techniques. This course may not be acceptable as a substitute for any other Probability and Statistics course. For Sustainable Urban Environments (SUE) students, please see your advisor. Note: This course is open to the following majors only: BIMS, IDM, STS, SUE. Not open to math majors or students who have taken or will take MA-UY 2054 or MA-UY 2224 or MA-UY 3014 or MA-UY 3514 or ECE-UY 2233 or equivalent.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No

MA-UY 2514 HONORS CALCULUS III (4 Credits)*Typically offered Fall and Spring*

Similar to MA-UY 2114 Calculus III, but at a faster pace and deeper level.

Functions of several variables. Vectors in the plane and space. Partial derivatives with applications, especially Lagrange multipliers. Double and triple integrals. Spherical and cylindrical coordinates. Surface and line integrals. Divergence, gradient, and curl. Theorem of Gauss and Stokes. Students pursuing an honors mathematics degree are especially encouraged to consider this course. Prerequisite: (MA-UY 1124 or MA-UY 1424) with a grade of A- or better OR a 5 on the AP Calculus BC Exam and Department Permission. Anti-requisite: MA-UY 2114

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** Prerequisite: (MA-UY 1124 or MA-UY 1424) with a grade of A- or better OR a 5 on the AP Calculus BC Exam and Department Permission.**MA-UY 3012 Introduction to Probability I (2 Credits)***Typically offered Fall, Spring, and Summer terms*

This course covers probability of events. Random variables. Discrete and continuous distributions. Joint distributions. Expectation. Functions of a random variable. Central limit theorem. | Prerequisite: MA-UY 2112 or MA-UY 2114.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 2112 or MA-UY 2114.**MA-UY 3014 APPLIED PROBABILITY (4 Credits)***Typically offered Fall and Spring*

An introduction to the mathematical treatment of random phenomena occurring in the natural, physical, and social sciences. Axioms of mathematical probability, combinatorial analysis, binomial distribution, Poisson and normal approximation, random variables and probability distributions, generating functions, the Central Limit Theorem and Laws of Large Numbers, Markov Chains, and basic stochastic processes. Note: Not open to students who have taken MA-UY 2224, MA-UY 2233, ECE-UY 2233 or MA-UY 3022 | Prerequisite: A grade of C or better in (MA-UY 2114 or MA-UY 2514) and (MA-UY 2034 or MA-UY 3034 or MA-UY 3044 or MA-UY 3054).

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** A grade of C or better in (MA-UY 2114 or MA-UY 2514) and (MA-UY 2034 or MA-UY 3034 or MA-UY 3044 or MA-UY 3054).**MA-UY 3022 PROBABILITY II (2 Credits)***Typically offered Fall and Spring*

This course covers multivariate random variables, moment generating functions, properties of expectation, limit theorems and gives an introduction to random processes and their applications. | Prerequisites: MA-UY 2224 or MA-UY 3012 Note: Not open to students who have taken MA-UY 2233

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 2224 or MA-UY 3012, Anti-Requisites: MA-UY 2224, MA-UY 2233, MA-UY 2414, MA-UY 2054 or MA-UY 3014.**MA-UY 3034 APPLIED LINEAR ALGEBRA (4 Credits)***Typically offered Fall, Spring, and Summer terms*

Systems of linear equations, matrices, determinants, vector spaces, eigenvalues and eigenvectors, orthogonality and least squares fit, singular value decompositions, computational techniques, conditioning, pseudo-inverses. | Prerequisites: MA-UY 1024 or MA-UY 1324.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 1024 or MA-UY 1324.**MA-UY 3054 Honors Linear Algebra (4 Credits)***Typically offered Fall and Spring*

This honors section of Linear Algebra is intended for well-prepared students who have already developed some mathematical maturity. Its scope will include the usual Linear Algebra (MA-UY 3044) syllabus; however, this class will move faster, covering additional topics and going deeper. Vector spaces, linear dependence, basis and dimension, matrices, determinants, solving linear equations, eigenvalues and eigenvectors, quadratic forms, applications such as optimization or linear regression.

Note: Not open to students who have already taken MA-UY 1533, MA-UY 2034, MA-UY 3044 or MA-UY 3113. | Prerequisites: A- or better in MA-UY 1024 or MA-UY 1324 or MA-UY 1022

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 3103 Problem Solving and Proofs (3 Credits)**

This course covers mathematical problem-solving, proofs and innovative reasoning. Discussion of independent challenging problems from Analysis, Complex Analysis, Probability, Combinatorics, Linear Algebra, Number Theory and Graph Theory. | Prerequisites: MA-UY 2312, MA-UY 2012.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 2312 with a Minimum Grade of D AND MA-UY 2012 with a Minimum Grade of D.**MA-UY 3112 Complex Variables I (2 Credits)***Typically offered Fall, Spring, and Summer terms*

This course covers functions of a complex variable. Derivatives and Cauchy-Riemann equations. Integrals and Cauchy integral theorem. Power and Laurent Series. Residue theory. | Prerequisite: MA-UY 2122 or equivalent.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 2122 with a Minimum Grade of D.**MA-UY 3113 Advanced Linear Algebra and Complex Variables (3 Credits)***Typically offered Spring*

This course provides a deeper understanding of topics introduced in MA-UY 2012 and MA-UY 2034 and continues the development of those topics, while also covering functions of a Complex Variable. Topics covered include: The Gram-Schmidt process, inner product spaces and applications, singular value decomposition, LU decomposition. Derivatives and Cauchy-Riemann equations, integrals and Cauchy integral theorem. Power and Laurent Series, residue theory. | Prerequisites: (MA-UY 2122 or MA-UY 2114 or MA-UY 2514) AND (MA-UY 2012 or MA-UY 2034). Note: Not open to students who have taken MA-UY 1533, MA-UY 3112 or MA-UY 4433.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No

MA-UY 3203 Linear Optimization (3 Credits)

This course examines linear optimization problems with constraints; optimality conditions and duality theory, the simplex method, complexity of the simplex method, interior point methods, selected applications, network flow problems and the network simplex method. | Prerequisites: MA-UY 2312, MA-UY 2112.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 2312 with a Minimum Grade of D AND MA-UY 2112 with a Minimum Grade of D.

MA-UY 3204 Linear and Nonlinear Optimization (4 Credits)

Typically offered Fall and Spring

This course provides an application-oriented introduction to linear programming and convex optimization, with a balanced combination of theory, algorithms, and numerical implementation. Theoretical topics will include linear programming, convexity, duality, and dynamic programming. Algorithmic topics will include the simplex method for linear programming, selected techniques for smooth multidimensional optimization, and stochastic gradient descent. Applications will be drawn from many areas, but will emphasize economics (eg two-person zero-sum games, matching and assignment problems, optimal resource allocation), data science (eg regression, sparse inverse problems, tuning of neural networks) and operations research (eg shortest paths in networks and optimization of network flows). While no prior experience in programming is expected, the required coursework will include numerical implementations, including some programming; students will be introduced to appropriate computational tools, with which they will gain experience as they do the assignments. | Prerequisites: A grade of C or better in (MA-UY 2114 or MA-UY 2514) and (MA-UY 2034 or MA-UY 3034 or MA-UY 3044 or MA-UY 3054).

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 3303 Differential Geometry (3 Credits)

This course covers: Curves and surfaces. Curvature. Forms. Gaussian curvature. Geodesics, minimal surfaces. Gauss-Bonnet Theorem. | Prerequisite: MA-UY 2122 or MA-UY 2114. Note: Not open to students who have taken MA-UY 4674.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 2122 or MA-UY 2114.

MA-UY 3514 Honors Probability (4 Credits)

Typically offered Spring

The aim of this class is to introduce students to probability theory, with a greater emphasis on rigor, more material, and a faster pace than the Theory of Probability/Applied Probability class. The material will include discrete and continuous probability, and the most fundamental limit theorems (law of large numbers and Central Limit Theorem). Students will be made familiar with the classical models, computations on densities, and convergence to universal distributions. They will also be expected to understand the proofs of all the results seen in class, and be able to argue with mathematical rigor. Note: While B+ or higher is the standard requirement for this course, the department will consider petitions sent to soe.math@nyu.edu if you are on the borderline of that requirement. Not open to students who have taken MA-UY 3014. | Prerequisites: MA-UY 2114 or MA-UY 2514 with a grade of B+ or better, and (MA-UY 2034 or MA-UY 3034 or MA-UY 3044 or MA-UY 3054) with a grade of B+ or better, and MA-UY 2314 with a grade of B+ or better. Anti-Requisites: MA-UY 3014

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 3604 MATHEMATICAL METHODS FOR PHYSICS AND ENGINEERING (4 Credits)

Typically offered Fall

First course of two-semester lecture sequence in mathematical physics for undergraduate students in physics and engineering. Line, surface and volume integrals, gradient, divergence, and curl. Cylindrical and spherical coordinate systems. Tensors and tensor transformations. The Dirac delta function, and integrals and derivatives of the delta function. Functions of complex variables, analytic functions, and the residue theorem. Fourier series, integrals, and transforms. | Prerequisites: PH-UY 2023 and MA-UY 2114; Co-requisites: PH-UY 2033 and (MA-UY 2034 or MA-UY 3044 or MA-UY 3054).

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 3914 PROJECT IN MATHEMATICS I (4 Credits)

Typically offered Fall and Spring

In this course, students read, study, and investigate selected topics in mathematics. Problems are discussed and presented by participating students. | Prerequisite: approval of departmental adviser. Note: This course is repeatable for credit, but does not allow multiple enrollment in the same term.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: Yes

MA-UY 4013 Introduction to Number Theory (3 Credits)

This course covers properties of integers and prime numbers. Congruences. Theorems of Fermat, Euler and Wilson. Quadratic residues. Diophantine equations. | Prerequisite: MA-UY 1124 or equivalent.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: (MA-UY 1112 with a Minimum Grade of D OR MA-UY 1124 with a Minimum Grade of D OR MA-UY 1424 with a Minimum Grade of D OR MA-UY 1412 with a Minimum Grade of D).

MA-UY 4014 Theory of Numbers (4 Credits)

Typically offered Fall

Divisibility and prime numbers. Linear and quadratic congruences. The classical number-theoretic functions. Continued fractions. Diophantine equations. | Prerequisites: C or better in MA-UY 1124, MA-UY 1424 or MA-UY 1132

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 4023 Elements of Abstract Algebra (3 Credits)

This course covers basic properties of groups, rings, fields, Euclidean rings and modules. Field extensions and Galois theory. Finite fields. | Prerequisite: MA-UY 2012.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

Prerequisites: MA-UY 2012 with a Minimum Grade of D.

MA-UY 4044 Algebra (4 Credits)

Typically offered Fall and Spring

Introduction to abstract algebraic structures, including groups, rings, and fields. Sets and relations. Congruences and unique factorization of integers. Groups, permutation groups, homomorphisms and quotient groups. Rings and quotient rings, Euclidean rings, polynomial rings. Fields, finite extensions. | Prerequisites: C or better in MA-UY 4614 and (MA-UY 3113, MA-UY 3044 or MA-UY 3054) ; or instructor permission. Note: Cannot receive credit for both MA-UY 4044 and MA-UY 4054.

Grading: Ugrd Tandon Graded

Repeatable for additional credit: No

MA-UY 4054 Honors Algebra I (4 Credits)*Typically offered Fall*

Introduction to abstract algebraic structures, including groups, rings, and fields. Sets and relations. Congruences and unique factorization of integers. Groups, permutation groups, group actions, homomorphisms and quotient groups, direct products, classification of finitely generated abelian groups, Sylow theorems. Rings, ideals and quotient rings, Euclidean rings, polynomial rings, unique factorization. | Prerequisites: B or better in MA-UY 4614 and (MA-UY 3044, MA-UY 3054 or MA-UY 3113); or instructor permission. Note: Cannot receive credit for both MA-UY 4044 and MA-UY 4054.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4064 Honors Algebra II (4 Credits)***Typically offered Spring*

Fields, finite extensions, constructions with ruler and compass, Galois theory, solvability by radicals. | Prerequisite: C or better in MA-UY 4054 or (a grade of A in MA-UY 4044 and instructor permission)

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** C or better in MA-UY 4054 or (a grade of A in MA-UY 4044 and instructor permission).**MA-UY 4114 Applied Statistics (4 Credits)***Typically offered Spring*

An introduction to the mathematical foundations and techniques of modern statistical analysis for the interpretation of data in the quantitative sciences. Mathematical theory of sampling; normal populations and distributions; chi-square, t, and F distributions; hypothesis testing; estimation; confidence intervals; sequential analysis; correlation, regression; analysis of variance. Applications to the sciences. Use of Matlab for doing computations of the statistical measures listed above. | Prerequisite: MA-UY 3014 or MA-UY 2233 or MA-UY 3514

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 3014 or MA-UY 2233 or MA-UY 3514.**MA-UY 4123 Statistical Methods (3 Credits)**

This course covers analysis of variance with simple experimental designs. Topics covered: Sampling procedures, including sequential analysis. Nonparametric statistical methods. Statistical decisions. | Prerequisite: MA-UY 4113.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 224 with a Minimum Grade of D.**MA-UY 4133 TIME SERIES (3 Credits)**

This course examines properties of time series, regression methods, linear processes, moving average processes, autoregressive processes, ARIMA models, autocorrelation, nonstationarity, parameter estimation, forecasting, regression models, ARCH, GARCH models, applications. | Prerequisite: MA-UY 2222.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** MA-UY 2222 with a Minimum Grade of D.**MA-UY 4204 Ordinary Diff Equations (4 Credits)***Typically offered Fall and Spring*

A first course in ordinary differential equations, including analytical solution methods, elementary numerical methods, and modeling. Topics to be covered include: first-order equations including integrating factors; second-order equations including variation of parameters; series solutions; elementary numerical methods including Euler's methods, Runge-Kutta methods, and error analysis; Laplace transforms; systems of linear equations; boundary-value problems. Restricted to Tandon math majors and students with a permission code from the math department. Fulfills ordinary differential equations requirement for the BS Math degree. | Prerequisites: C or better in (MA-UY 2114 or MA-UY 2514 or MATH-UH 1020 or MATH-UH 1021 or MATH-SHU 151) and (MA-UY 3044 or MA-UY 3054 or MA-UY 3113 or MATH-UH 1022 or MATH-SHU 140 or MATH-SHU 141). Note: Not open to students who have taken MA-UY 2034 or MA-UY 4254

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4204G Ordinary Diff Equations (4 Credits)**

A first course in ordinary differential equations, including analytical solution methods, elementary numerical methods, and modeling. Topics to be covered include: first-order equations including integrating factors; second-order equations including variation of parameters; series solutions; elementary numerical methods including Euler's methods, Runge-Kutta methods, and error analysis; Laplace transforms; systems of linear equations; boundary-value problems. Restricted to Tandon math majors and students with a permission code from the math department. Fulfills ordinary differential equations requirement for the BS Math degree. | Prerequisites: C or better in (MA-UY 2114 or MA-UY 2514 or MATH-UH 1020 or MATH-UH 1021 or MATH-SHU 151) and (MA-UY 3044 or MA-UY 3054 or MA-UY 3113 or MATH-UH 1022 or MATH-SHU 140 or MATH-SHU 141). Note: Not open to students who have taken MA-UY 2034 or MA-UY 4254

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4214 Applied Ordinary Differential Equations (4 Credits)***Typically offered Fall and Spring*

A first course in ordinary differential equations, including analytical solution methods, elementary numerical methods, and modeling. Topics to be covered include: first-order equations including integrating factors; second-order equations including variation of parameters; series solutions; elementary numerical methods including Euler's methods, Runge-Kutta methods, and error analysis; Laplace transforms; systems of linear equations; boundary-value problems. Restricted to Tandon math majors and students with a permission code from the math department. Fulfills ordinary differential equations requirement for the BS Math degree. Note: Not open to students who have taken MA-UY 2034 or MA-UY 4204. | Prerequisites: (MA-UY 2114 or MA-UY 2514) and (MA-UY 3034 or MA-UY 3044 or MA-UY 3054).

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No

MA-UY 4254 HONORS ORDINARY DIFFERENTIAL EQUATIONS (4 Credits)*Typically offered Fall*

This class will develop rigorously the basic theory of Ordinary Differential Equations (ODEs). Existence and uniqueness of solutions to ODEs are first investigated, for linear and nonlinear problems, set on the real line or the complex plane. More qualitative questions are then considered, about the behavior of the solutions, with possible prolongations to various topics in Dynamical Systems theory. Applications to Physics and Biology will appear naturally when discussing examples. | Prerequisites: A grade of A- or higher in MA-UY 4614 or a grade of B+ or higher in MA-UY 4644. Anti-requisite: MA-UY 4204 or MA-UY 2034

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4314 Combinatorics (4 Credits)***Typically offered Spring*

Techniques for counting and enumeration including generating functions, the principle of inclusion and exclusion, and Polya counting. Graph theory. Modern algorithms and data structures for graph-theoretic problems. | Prerequisite: C or better in MA-UY 1124, MA-UY 1424 or MA-UY 1132

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**Prerequisites:** C or better in MA-UY 1124, MA-UY 1424 or MA-UY 1132.**MA-UY 4324 MATHEMATICS OF FINANCE (4 Credits)***Typically offered Fall and Spring*

Introduction to the mathematics of finance. Topics include: Linear programming with application pricing and quadratic. Interest rates and present value. Basic probability: random walks, central limit theorem, Brownian motion, lognormal model of stock prices. Black-Scholes theory of options. Dynamic programming with application to portfolio optimization. | Prerequisites: A grade of C+ or better in (MA-UY 2114 or MA-UY 2514) and a grade of C+ or better in (MA-UY 2054 or MA-UY 2224 or MA-UY 2233 or MA-UY 2414 or MA-UY 3014 or MA-UY 3022 or MA-UY 3514 or MA-UY 4114).

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4414 APPLIED PARTIAL DIFFERENTIAL EQUATIONS (4 Credits)***Typically offered Fall and Spring*

This course gives an overview of PDEs that occur commonly in the physical sciences with applications in heat flow, wave propagation, and fluid flow. Analytical as well as some numerical solution techniques will be covered, with a focus on applications rather than analysis. | Prerequisites: MA-UY 2034 or MA-UY 4204 or MA-UY 4254

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4424 NUMERICAL ANALYSIS (4 Credits)***Typically offered Spring*

In numerical analysis one explores how mathematical problems can be analyzed and solved with a computer. As such, numerical analysis has very broad applications in mathematics, physics, engineering, finance, and the life sciences. This course gives an introduction to this subject for mathematics majors. Theory and practical examples using Matlab will be combined to study a range of topics ranging from simple root-finding procedures to differential equations and the finite element method. | Prerequisites: A grade of C or better in (MA-UY 2114 or MA-UY 2514) and (MA-UY 3034 or MA-UY 3044 or MA-UY 3054 or MA-UY 3113) | Anti-Requisite: MA-UY 4524

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4434 Applied Complex Variables (4 Credits)***Typically offered Spring*

A first course in complex analysis, with a focus on applications. Topics to be covered include the complex plane, analytic functions, complex differentiation, the Cauchy-Riemann equations, branch cuts, contour integration, the residue theorem, conformal mapping, applications to potential theory and fluid flow. Note: Not open to students who have taken MA-UY 3113. | (MA-UY 2114 or MA-UY 2514) and (MA-UY 2034 or MA-UY 3034 or MA-UY 3044 or MA-UY 3054)

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4444 Intro to Math Modeling (4 Credits)***Typically offered Fall and Spring*

Formulation and analysis of mathematical models. Mathematical tools include dimensional analysis, optimization, simulation, probability, and elementary differential equations. Applications to biology, sports, economics, and other areas of science. The necessary mathematical and scientific background will be developed as needed. Students participate in formulating models as well as in analyzing them. | Prerequisites: C or better in MA-UY 2114 or MA-UY 2514 Note: Not open to students who have taken MA-UY 2393.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4474 Chaos and Dynamical Systems (4 Credits)***Typically offered Spring*

Topics will include dynamics of maps and of first order and second-order differential equations, stability, bifurcations, limit cycles, dissection of systems with fast and slow time scales. Geometric viewpoint, including phase planes, will be stressed. Chaotic behavior will be introduced in the context of one-variable maps (the logistic), fractal sets, etc. Applications will be drawn from physics and biology. There will be homework and projects, and a few computer lab sessions (programming experience is not a prerequisite). | Prerequisites: C or better in (MA-UY 1124, MA-UY 1424 or MA-UY 1132) and (MA-UY 3044, MA-UY 3054 or MA-UY 3113)

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4614 Applied Analysis (4 Credits)***Typically offered Fall and Spring*

Limits of real and complex sequences and series; topology of metric spaces; continuity and differentiability of functions; definition, properties, and approximations of Riemann integrals; convergence of sequences and series of functions; Fourier series and other orthogonal systems of functions, approximations theorems. | Prerequisites: (MA-UY 2114 or MA-UY 2514) and (MA-UY 2034 or MA-UY 3034 or MA-UY 3044 or MA-UY 3054) and Junior level standing or above.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4623 ANALYSIS II (3 Credits)***Typically offered Spring*

Description: This course covers the study of basic topics in analysis with emphasis on methods. The Riemann integral, line integrals, improper integrals, integrals with parameters, transformations, Riemann-Stieltjes integral, uniform and absolute convergence of integrals, sequences, series, uniform convergence, Beta and Gamma functions. | Prerequisites: MA-UY 4613

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No

MA-UY 4634 Vector Analysis (4 Credits)*Typically offered Spring*

Brief review of multivariate calculus: partial derivatives, chain rule, Riemann integral, change of variables, line integrals. Lagrange multipliers. Inverse and implicit function theorems and their applications. Introduction to calculus on manifolds: definition and examples of manifolds, tangent vectors and vector fields, differential forms, exterior derivative, line integrals and integration of forms. Gauss' and Stokes' theorems on manifolds. | Prerequisites: C or better in MA-UY 4613

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4644 HONORS ANALYSIS I (4 Credits)***Typically offered Fall*

This is an introduction to the rigorous treatment of the foundations of real analysis in one variable. It is based entirely on proofs. Students are expected to know what a mathematical proof is and are also expected to be able to read a proof before taking this class. Topics include: properties of the real number system, sequences, continuous functions, topology of the real line, compactness, derivatives, the Riemann integral, sequences of functions, uniform convergence, infinite series and Fourier series. Additional topics may include: Lebesgue measure and integral on the real line, metric spaces, and analysis on metric spaces. | Prerequisites: A grade of A- or better in (MA-UY 2114 or MA-UY 2514) and (MA-UY 2034 or MA-UY 3044 or MA-UY 3054) and Junior level standing or above. Recommended: MA-UY 2514 Honors Calculus III and MA-UY 3054 Honors Linear Algebra with a grade of B+ or better.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4654 HONORS ANALYSIS II (4 Credits)***Typically offered Spring*

This is a continuation of MATH-UA 328/MA-UY 4644 Honors Analysis I. Topics include: metric spaces, differentiation of functions of several real variables, the implicit and inverse function theorems, Riemann integral on \mathbb{R}^n , Lebesgue measure on \mathbb{R}^n , the Lebesgue integral. | Prerequisites: A grade of C or better in MA-UY 4644 or a grade of A in MA-UY 4614 in conjunction with permission by instructor

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4674 Differential Geometry (4 Credits)***Typically offered Spring*

The differential properties of curves and surfaces. Introduction to manifolds and Riemannian geometry. | Prerequisites: C or better in (MA-UY 2114 or MA-UY 2514) and (MA-UY 3044, MA-UY 3054 or MA-UY 3113).

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4684 Topology (4 Credits)***Typically offered Spring*

Set-theoretic preliminaries. Metric spaces, topological spaces, compactness, connectedness, covering spaces, and homotopy groups. | Prerequisites: A grade of C or better in (MA-UY 4614 or MA-UY 4644)

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4814 Honors I (4 Credits)***Typically offered Fall and Spring*

A lecture/seminar course on advanced topics. Topics vary yearly and are updated from time to time. Detailed course descriptions are available during preregistration. | Prerequisite varies according to topic. Department Consent Required for Enrollment.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4824 Honors II (4 Credits)***Typically offered Fall and Spring*

A lecture/seminar course on advanced topics. Topics vary yearly and are updated from time to time. Detailed course descriptions are available during preregistration. | Prerequisite varies according to topic. Department Consent Required for Enrollment.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4834 Honors III (4 Credits)***Typically offered Fall and Spring*

A lecture/seminar course on advanced topics. Topics vary yearly and are updated from time to time. Detailed course descriptions are available during preregistration. | Prerequisite varies according to topic. Department Consent Required for Enrollment.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4844 Honors IV (4 Credits)***Typically offered Fall and Spring*

A lecture/seminar course on advanced topics. Topics vary yearly and are updated from time to time. Detailed course descriptions are available during preregistration.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No**MA-UY 4993 Thesis for Bachelor of Science Degree (3 Credits)***Typically offered occasionally*

This course provides the framework for a bachelor's thesis. In the Bachelor's thesis, a student reports on an independent investigation of a topic in Mathematics that demonstrates an in-depth knowledge of that area of Mathematics and proficiency in using its specific methods. | Prerequisite: Departmental adviser's approval.

Grading: Ugrd Tandon Graded**Repeatable for additional credit:** No