## MATHEMATICS (MA)

### MA 100. Basic Algebra. 3 Credits.
This course reviews basic arithmetic and algebraic skills and introduces mathematical methods to the entering student with little or no mathematics background, with the goal of providing sufficient skill to take coursework requiring two years of college preparatory mathematics. Students are expected to participate in three hours of coursework per week. MA 100 is for institutional credit and does not apply to graduation requirements. Note: Students may not withdraw from MA 100. Students who fail MA 100 the first time receive a grade of Unsatisfactory. If the student does not pass the second time, then a failure is recorded on the student's record.

**Offered:** Every year, Fall and Spring

### MA 107. College Algebra. 3 Credits.
This course reviews the fundamentals of algebra. Students learn about the following topics: the real number system, factoring and expanding polynomials, properties of logarithms and exponentials, linear equations and inequalities, quadratic equations and inequalities, absolute value equations and inequalities, systems of equations and inequalities, functions and their graphs, and algebra of functions, including composition, and inverse functions. This course is designed for students who need to improve their algebraic skills to prepare for future mathematics courses such as Applied Calculus, Pre-Calculus, or Statistics. MA 107 does not fulfill the Quantitative Literacy requirement.

**Prerequisites:** A math placement level of 2 or above, or successful completion of MA 100.

**Offered:** Every year, All

### MA 110. Contemporary Mathematics. 3 Credits.
This course introduces students to the study of mathematics as a discipline and also presents topics that are applicable to students' everyday lives. Topics include logic, probability and statistics and financial mathematics. The course also covers two topics from the following list: geometry, set theory, number theory, measurement, problem solving, mathematical systems, scientific applications, history of mathematics. Topics are chosen by the instructor. Students should check the mathematics requirements for their major before selecting their first course in mathematics. MA 110 is not designed to be a prerequisite for any calculus course. Prerequisite: A math placement level of 2 or above, or successful completion of MA 100.

**Offered:** Every year, All

### MA 140. Pre-Calculus. 3 Credits.
This course concentrates on topics that students need to understand profoundly to succeed in calculus. Students learn about the following topics: functions and their graphs, exponents and logarithms and trigonometry. There is a focus on basic concepts and visualization of problems. The material has many real-life applications. Use of a TI-83 or TI-84 calculator is required. Primary emphasis is on developing the following New Synthesis proficiencies: quantitative reasoning and critical thinking and reasoning.

**Prerequisites:** Take MA 107; Minimum grade C- or placement level of 3.

**Offered:** Every year, All

**UC:** Breadth Elective, University Curriculum Ele

### MA 141. Calculus of a Single Variable. 3 Credits.
This course covers functions, graphs, limits, continuity, derivatives, applications of derivatives, antiderivatives and definite integrals, as well as the Fundamental Theorem of Calculus. This course significantly advances the following Essential Learning Outcomes: quantitative reasoning, critical thinking and reasoning. Many sections require a TI-83/84 calculator (or the equivalent); check with the instructor. Students cannot receive credit for both MA 141 and MA 151.

**Prerequisites:** Take MA 140; Minimum grade C; or placement level of 5.

**Offered:** Every year, All

**UC:** Breadth Elective, University Curriculum Ele

### MA 141H. Honors Calculus of a Single Variable. 3 Credits.
This course covers functions, graphs, limits, continuity, derivatives, applications of derivatives, antiderivatives and definite integrals, as well as the Fundamental Theorem of Calculus. This course significantly advances the following Essential Learning Outcomes: quantitative reasoning, critical thinking and reasoning. Many sections require a TI-83/84 calculator (or the equivalent); check with the instructor. Students cannot receive credit for both MA 141 and MA 151.

**Prerequisites:** Take MA 140; Minimum grade C; or placement level of 5.

**Offered:** As needed

**UC:** University Curriculum Ele

### MA 150. Integral Calculus With Applications. 1 Credit.
This course provides a bridge from MA 140 to MA 152 or MA 153. Students review basic integration rules, integration by substitution, The Fundamental Theorem of Calculus, numerical integration and applications of integration, including area between curves, volumes, arc length and applications from physics. A graphing calculator is required; the TI-83 or TI-84 is recommended.

**Prerequisites:** Take MA 140 or MA 141H; Minimum grade C-

**Offered:** Every year, Fall and Spring

### MA 151. Calculus I. 4 Credits.
This course covers functions and graphs, limits and continuity, derivatives, applications of derivatives, antiderivatives and definite integrals, the Fundamental Theorem of Calculus, numerical integration and applications of definite integrals. A graphing calculator is required; the TI-83 or TI-84 is recommended. Students cannot receive credit for both MA 151 and MA 141.

**Prerequisites:** Take MA 140; Minimum grade C; or placement level of 5.

**Offered:** Every year, Fall and Spring

**UC:** Breadth Elective, University Curriculum Ele

### MA 152. Calculus II. 4 Credits.
This course covers techniques of integration, improper integrals, differential equations, infinite series, parametric equations, polar coordinates, vectors, operations on vectors, and three-dimensional coordinate systems.

**Prerequisites:** Take MA 151 or MA 141; Minimum grade C-

**Corequisites:** Take MA 150.

**Offered:** As needed
MA 153. Calculus II: Part A. 2 Credits.
Students in this course study techniques of integration and infinite sequences and series. Techniques studied include u-substitution, integrals involving logarithms and inverse trigonometric functions, trigonometric integrals, trigonometric substitution, integration by parts, and partial fractions. For infinite series, the course includes a study of convergence, tests of convergence, power series, and Taylor and Maclaurin series. Additional topics include indeterminate forms, L'Hopital's Rule, and improper integrals. Offered the first half of each semester.
Prerequisites: Take MA 141 or MA 151. Minimum Grade C-.
Offered: Every year, Fall and Spring

MA 154. Calculus II: Part B. 2 Credits.
In this course students study differential equations, conic sections, parametric equations, polar coordinates, vectors, operations on vectors, lines and planes in space, three-dimensional coordinate systems (cylindrical and spherical coordinates) and quadric surfaces. Offered the second half of each semester.
Prerequisites: MA 151; or MA 141 and MA 150; Minimum grade C-.
Corequisites: Take MA 153.
Offered: Every year, Fall and Spring

MA 170. Probability and Data Analysis. 3 Credits.
This course teaches students the fundamentals of probability and solves real-life probability problems. Students learn to use graphical techniques and descriptive statistics to analyze data. Topics include: ratios, proportions, percentages, empirical and theoretical probability calculations, conditional probability and independence, Bayes’ Theorem, expected value, discrete probability distributions, continuous probability distributions, descriptive statistics for central tendency and variability, graphical techniques including histograms and scatter diagrams, and analyzing data sets. The course also includes an introduction to Excel and prepares students for future courses in statistics and analytics.
Prerequisites: Take MA 100; Minimum grade C-; or placement level of 2.
Offered: Every year, Fall and Spring
UC: Breadth Elective

MA 176. Baseball and Statistics (SPS 176). 3 Credits.
This course covers Sabermetrics: the use of standard statistical topics to analyze data derived from baseball records. The book, "Moneyball," is read to understand how Billy Beane used statistics to bring success to the Oakland Athletics. The standard statistical topics covered include exploratory data analysis, elementary probability, discrete probability distributions, normal probability distributions, sampling distributions, regression and correlation. Learning to use Excel to do statistical analysis is an integral part of the course. Students must possess a basic knowledge of baseball.
Prerequisites: Take MA 100; or placement level of 2.
Offered: Every year, Fall and Spring
UC: Breadth Elective

MA 205. Introduction to Discrete Mathematics (CSC 205). 3 Credits.
This course introduces students to basic concepts and structures of discrete mathematics. Topics can include propositional and predicate logic, sets and set operations, functions, proof techniques, counting problems, probability and basic number theory. Applications include computer science, biology, social sciences, law and the physical sciences.
Prerequisites: Take CSC 110 or MA 110 or higher; Grade of C- or better.
Offered: Every year, Spring

MA 206. Statistics for the Behavioral Sciences. 3 Credits.
This course presents a study of statistical procedures pertinent to the work of the social and behavioral scientist. Students are introduced to descriptive procedures, confidence intervals, hypothesis testing, regression and correlation, analysis of variance and non-parametric techniques. Students are not allowed to receive credit for more than one of the following courses: MA 206, MA 275 and MA 285.
Prerequisites: Take MA 107 MA 170 or MA 176; Minimum grade C-; or placement level of 3.
Offered: Every year, All

MA 229. Linear Algebra. 3 Credits.
This course covers the basic concepts of linear algebra, along with an introduction to the language and techniques of formal mathematics. Topics include systems of linear equations, vector spaces, linear transformations, matrices, determinants and eigenvalues.
Offered: Every year, Spring

MA 251. Calculus III. 4 Credits.
This course covers vector functions, derivatives and integrals of vector functions, arc length and curvature, motion in space, functions of several variables, limits and continuity, partial derivatives, tangent planes and linear approximations, directional derivatives and the gradient vector, maximum and minimum values, Lagrange multipliers, multiple integration in Cartesian, cylindrical and spherical coordinates, surface area, vector fields, line integrals, Green's theorem, curl and divergence, surface integrals, Stoke's theorem and divergence theorem.
Prerequisites: Take MA 152 or MA 154; Minimum grade C-.
Offered: Every year, Fall

MA 265. Matrix Algebra and Differential Equations. 4 Credits.
This course covers the basic concepts of both linear algebra and ordinary differential equations with an emphasis on applications in science and engineering. Linear algebra topics include systems of linear equations, vector spaces and subspaces, linear transformations, matrix algebra, determinants and eigenvalues. Differential equation topics include solutions to first, second and higher order homogeneous and nonhomogeneous differential equations. Solution methods include use of eigenvalues and eigenvectors, Laplace transforms, infinite series and numerical approximations. Special differential equations including Legendre, Bessel, Hermite and Chebyshev equations also are discussed as well as transformations for autonomous equations. A graphing calculator is recommended (TI-83 or TI-84) as well as knowledge of Excel.
Prerequisites: Take MA 152 or MA 153; Minimum grade C-.
Offered: Every year, Spring

MA 275. Biostatistics. 3 Credits.
Students are introduced to the application of statistical techniques to the biological and health sciences with emphasis on probability laws, sampling and parameter estimation, central limit theorem, test of hypothesis, correlation, regression and analysis of variance. Students are not allowed to receive credit for more than one of the following courses: MA 206, MA 275 and MA 285.
Prerequisites: Take MA 107 MA 170, MA 176 or MA 140; Minimum grade C- or placement level of 4.
Offered: Every year, All

MA 275H. Honors Biostatistics. 3 Credits.
Students are introduced to the application of statistical techniques to the biological and health sciences with emphasis on probability laws, sampling and parameter estimation, central limit theorem, test of hypothesis, correlation, regression and analysis of variance.
Prerequisites: Take MA 107 MA 170 MA 176 or MA 140; Minimum grade C- or placement level of 4.
Offered: As needed
MA 285. Applied Statistics. 3 Credits.
This introductory statistics course is intended primarily for students majoring in engineering, mathematics or the sciences. Emphasis is on using statistics to answer questions in the physical and social sciences. Topics include descriptive statistics, probability, point and interval estimation, hypothesis testing, correlation and regression, analysis of variance, chi-square tests and nonparametric methods. Students are required to analyze real data sets using Excel, SAS, SPSS or similar computer programs. Students are not allowed to receive credit for more than one of the following courses: MA 206, MA 275 and MA 285.
Prerequisites: Take MA 141, MA 141H or MA 151; Minimum grade C-.
Offered: Every year, Spring

MA 299. Independent Study in Mathematics. 1-6 Credits.
This individual study in a specialized area is open to juniors and seniors by special arrangement with the department chairman. This is a structured program of reading, problem solving and experiments established through conferences with a member of the mathematics faculty. Graded by examination or term project.
Offered: Every year, All

MA 300. Special Topics. 3 Credits.
Offered: As needed, All

MA 301. Foundations of Advanced Mathematics. 3 Credits.
This course is an exploration of the language and nature of mathematics. Emphasis is placed on developing the students’ ability to construct and write mathematical proofs and helping students read and understand mathematical reasoning. Various techniques of proof are discussed, including direct, contrapositive, induction, contradiction and counterexample. Mathematical content includes elementary logic, quantifiers, set theory, relations, functions and number systems. Other topics are at the instructor’s discretion, and may include number theory, graph theory, point-set topology or counting problems.
Prerequisites: Take MA 229 or MA 205; Minimum grade C-.
Offered: Every year, Fall

MA 305. Discrete Mathematics. 3 Credits.
Students study various topics in discrete mathematics, such as proof by induction, recurrence relations, cardinality of a set, the pigeonhole principle, counting techniques, probability and graph theory.
Prerequisites: Take MA 301 or CSC 205; Minimum grade C-.
Offered: Every other year, Fall

MA 315. Theory of Computation (CSC 315). 3 Credits.
This course provides an introduction to the classical theory of computer science with the aim of developing a mathematical understanding of the nature of computing by trying to answer one overarching question: "What are the fundamental capabilities and limitations of computers?" Specific topics include finite automata and formal languages (How do we define a model of computation?), computability (What can be computed? and How do we prove something cannot be computed?) and complexity (What makes some problems so much harder than others to solve? and What is the P versus NP question and why is it important?).
Prerequisites: Take MA 301 or CSC 215; Minimum grade C-.
Offered: Every other year, Fall

MA 318. Cryptography (CSC 318). 3 Credits.
Students study methods of transmitting information securely in the face of a malicious adversary deliberately trying to read or alter it. Participants also discuss various possible attacks on these communications. Students learn about classical private-key systems, the Data Encryption Standard (DES), the RSA public-key algorithm, discrete logarithms, hash functions and digital signatures. Additional topics may include the Advanced Encryption Standard (AES), digital cash, games, zero-knowledge techniques and information theory, as well as topics chosen by the students together with the instructor for presentations.
Prerequisites: Take MA 229 or CSC 215. Minimum grade C-.
Offered: Every other year, Spring

MA 321. Abstract Algebra. 3 Credits.
This course presents a study of topics selected from groups, normal groups, rings, ideals, integral domains, fields, polynomial rings and isomorphism theorems.
Prerequisites: Take MA 229, MA 301; Minimum grade C-.
Offered: Every year, Spring

MA 341. Advanced Calculus. 3 Credits.
The concepts of limit, continuity, differentiation and Riemann integration are studied in depth. Also considered are sequences and series, improper integrals, and Riemann-Stieltjes Integral.
Prerequisites: Take MA 152 or MA 153; and MA 301 Minimum grade C-.
Offered: Every year, Fall

MA 351. Real Analysis. 3 Credits.
This course examines the theoretic foundations of continuity, differentiation and integration at a more abstract level than MA 341. The class reinforces and further expands on proof techniques covered in MA 301. Topics include: convergence of sequences and series, construction of the real number system, metric spaces, dense sets, continuity, compactness, connectedness, differentiation, Riemann-Stieltjes Integral and sequences of functions. Students who wish to pursue graduate studies in mathematics are strongly encouraged to take this class. It is recommended that students take MA 341 before attempting this class.
Prerequisites: Take MA 142 or MA 152 and MA 301; Minimum grade C-.
Offered: Every other year, Spring

MA 365. Ordinary Differential Equations. 3 Credits.
Students are introduced to standard methods for solving ordinary differential equations, including Laplace transforms as well as singular solutions, series solutions and the system of linear differential equations. Existence and uniqueness theorems are also introduced, as are geometrical interpretation and applications.
Prerequisites: Take MA 152 or MA 154; and MA 229; Minimum grade C-.
Offered: Every other year, Fall

MA 370. Number Theory. 3 Credits.
Topics include representation of integers, primes, the Fundamental Theorem of Arithmetic, divisibility, modular arithmetic, Fermat’s Little Theorem and Euler's Theorem, perfect numbers, and Diophantine equations. Additional topics may include quadratic residues, sums of squares, and Fermat’s Last Theorem.
Prerequisites: take 1 course; from subject MA; from level 300; Minimum grade C-.
Offered: Every other year, Spring
MA 371. Mathematical Statistics and Probability I. 3 Credits.
This course covers foundations of probability, random variables and select probability distributions with applications. Topics include sample spaces and events; conditional probability; independence; expected value, variance and other moments; joint densities; and probability distributions including the normal, Poisson, Binomial and other distributions.
Prerequisites: Take MA 251 MA 301; Minimum grade C-.
Offered: Every other year, Fall

MA 372. Mathematical Statistics and Probability II. 3 Credits.
Students are introduced to general principles of estimation and testing hypotheses; small sample distributions; regression and correlation; design of experiments and analysis of variance; nonparametric techniques; and other methods.
Prerequisites: Take MA 371; Minimum grade C-.
Offered: Every other year, Spring

MA 378. Mathematical Modeling. 3 Credits.
Students develop mathematical models for problems in biology, environment, health sciences and politics.
Prerequisites: Take MA 141, MA 141H or MA 151 and MA 229; Minimum grade C-.
Offered: Every other year, Fall

MA 399. Independent Study in Mathematics. 1-6 Credits.
This individual study in a specialized area is open to juniors and seniors by special arrangement with the department chairman. This is a structured program of reading, problem solving and experiments established through conferences with a member of the mathematics faculty. Graded by examination or term project.
Offered: As needed, Spring

MA 421. Advanced Algebra. 3 Credits.
Advanced topics in algebra include Sylow theorems (groups), field extensions, and Galois theory. If time permits, Jordan form of matrices, modules, and introduction to category theory are included.
Prerequisites: Take MA 321; Minimum grade C-.
Offered: As needed, Spring

MA 451. Elements of Point-Set Topology. 3 Credits.
Open sets, closed sets and topological spaces are considered. Also covered are connectedness and compactness, functions, limit points and continuity. Metric spaces are introduced as well as completeness and the Heine-Borel property. Construction of real numbers is introduced.
Prerequisites: Take MA 341; Minimum grade C-.
Offered: As needed

MA 490. Mathematics Senior Seminar. 3 Credits.
Students work on a senior-level project, culminating in a written and oral report. For senior mathematics majors.
Offered: Every year, Spring

MA 499. Independent Study in Mathematics. 1-6 Credits.
This individual study in a specialized area is open to juniors and seniors by special arrangement with the department chairman. This is a structured program of reading, problem solving and experiments established through conferences with a member of the mathematics faculty. Graded by examination or term project.
Offered: As needed, Spring