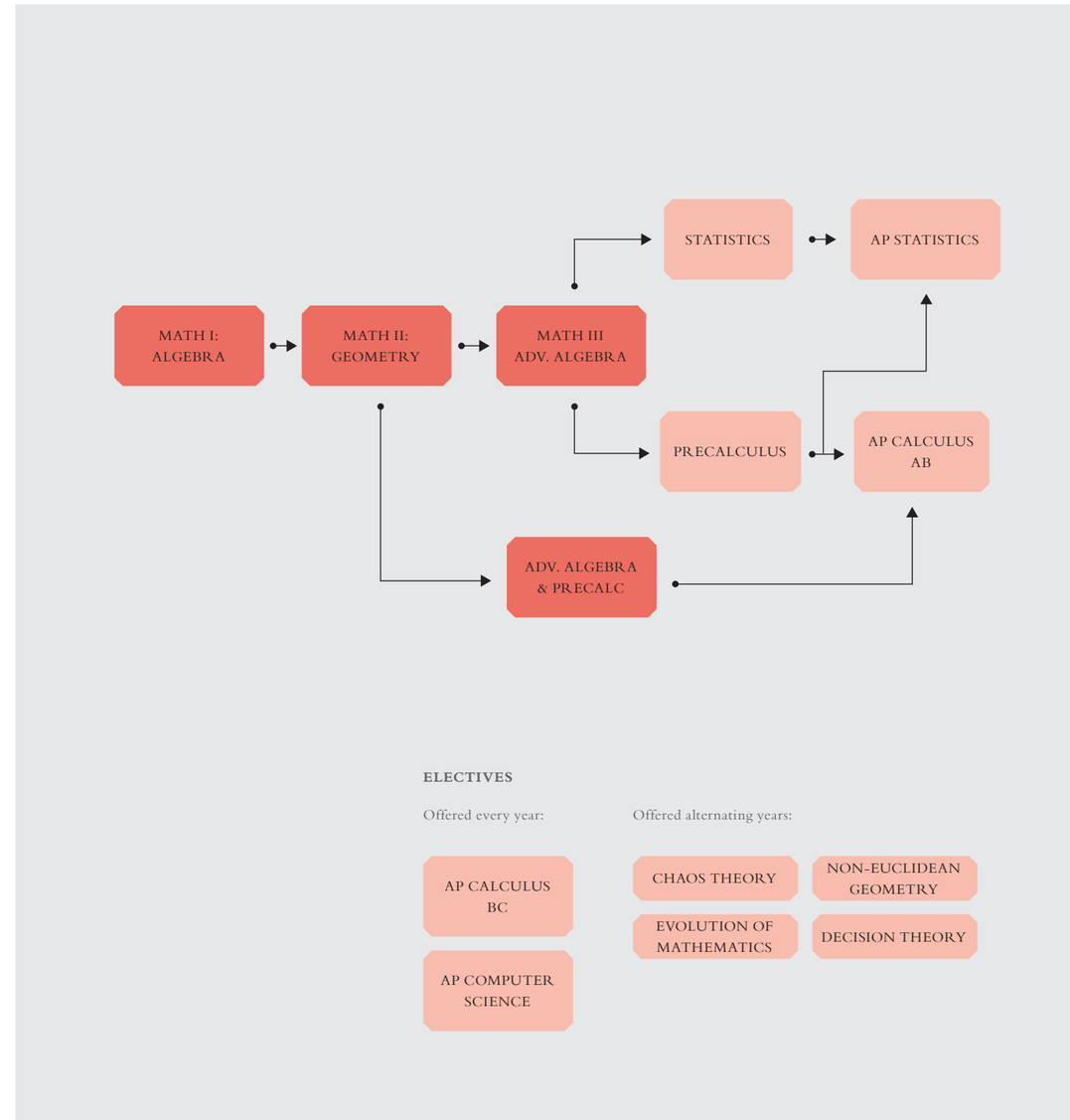
MATHEMATICS

The Mathematics requirement for graduation consists of a three-year sequence of courses: Mathematics I, II, and III. These courses emphasize modes of mathematical reasoning and techniques of problem solving through the traditional topics of algebra, geometry, and right-triangle trigonometry. Students who wish to continue their study of mathematics have a variety of electives to choose from. Precalculus, Statistics, AP Calculus, AP Statistics, and AP Computer Science are offered every year. There is also a changing menu of various special electives that are offered occasionally, including Non-Euclidean Geometry, Chaos Theory, Discrete Mathematics, Evolution of Mathematics, and Decision Theory.

MATHEMATICS



REQUIRED COURSE

ELECTIVE COURSE

FULL-YEAR

SEMESTER-LONG

FULL YEAR COURSES

MATH I: ALGEBRA

This is a course in first-year algebra. Basic skills and concepts are introduced and constantly reinforced. Students focus on the interrelationships of the most important ideas: ratios, graphing, problem-solving strategies, and writing and solving equations. The course is built around problems—lots of problems—which address these important ideas in a variety of contexts.

- Prerequisite: none

MATH II: GEOMETRY

In this course we will study plane Euclidean geometry from both an inductive and deductive approach. We will introduce the concept of proof, which is, to the mathematician, what the painting is to the artist. Students will learn (and mostly prove) the classical theorems concerning lines, angles, polygons, and circles. The course develops an awareness of shape and form, as well as an enhancement of visualization skills. Cooperative learning will form a major part of the pedagogy.

- Prerequisite: eighth-grade course in algebra and satisfactory performance on a placement examination, or Math I

MATH III: ADVANCED ALGEBRA

This course covers concepts and techniques of advanced algebra, with an emphasis on problem solving and mathematical modeling. Topics covered include the investigation of functions (linear, quadratic, exponential, logarithmic, and variation); the unit circle; right triangle trigonometry, counting; and probability. This course prepares the student for the M1 SAT II Subject Test.

- Prerequisite: Math II

ADVANCED ALGEBRA AND PRECALCULUS

This is an accelerated (fast-paced) course for 10th- or 11th-graders that covers all of the material in Math III, Precalculus-A, and Precalculus-B, in a single year. It is not an appropriate math course for most students.

- Prerequisite: Math II and permission of the department; must be in either 10th or 11th grade

DESCRIPTIVE STATISTICS/INFERENTIAL STATISTICS

For better or worse, statistics is all around us. Every day, in the newspapers, on TV, we are bombarded with statistics, most of which try to convince us of one thing or another. Should we believe them? On what will we base our assessments? In this course, we will explore the ideas behind design of experiments, data summary and analysis, and linear correlation and regression. This course, in conjunction with Inferential Statistics (the heart of statistics), will help you become a more critical thinker, savvy consumer, and informed citizen; this two-semester sequence will also prepare you for a statistics course in college, or for our own AP Statistics course.

This second semester in statistics will address probability and the fundamental topic of inference. Given the results of a random sample, what inferences can one make about the larger population from which the sample was taken? How such error is associated with this inference? When is this inference valid or not valid? We will look at sample surveys and investigate why all the newspapers erroneously declare Dewey the winner in the 1948 presidential election. We will also study confidence intervals and tests of significance and see how these can be used to make inferences about unknown population characteristics. Additional topics will include: the Gambler's Fallacy and Roulette, how to test for loaded coins, and how to determine when one can confidently say that one treatment is superior to another treatment.

- Prerequisite: Math III

PRECALCULUS-A/ PRECALCULUS-B

This two-semester sequence in precalculus is for students intending to take a rigorous college course in Calculus (or our own AB Calculus AP). Topics include: a review of linear and quadratic functions, higher degree polynomial functions, linear and polynomial inequalities, inverse functions, transformations of functions, analytic geometry of lines and conics and an introduction to complex numbers. This course also focuses on trigonometric functions which describe AM/FM radio waves, the patterns of tides, and the daily change in the time of sunset. Topics include: trig equations and applications; identities, addition, double-angle and half-angle formulas; polar coordinates and complex numbers; and a return to triangle trigonometry from an advanced standpoint. In special cases, with permission of the department, students may choose to only enroll in Precalculus-A. Students must complete Precalculus-A, or some equivalent course, to enroll in Precalculus-B. The entire two-semester sequence prepares the student for the M2 SAT II Subject Test.

- Prerequisite: Math III with a grade of B+ or better, or permission of the department

AP CALCULUS AB

A one-year study of the basic topics of differential and integral calculus, including functions (polynomial, rational; irrational; trigonometric, and logarithmic), limits, the derivative and applications of differentiation; curve sketching; the integral; and applications such as rectilinear motion, area, and volumes. This class is for those able and motivated in mathematics and students will be expected to sit for the AB Advanced Placement Exam.

- Prerequisite: Precalculus-B, or Advanced Algebra and Precalculus, and permission of the department

AP CALCULUS BC

BC Calculus includes a review of AB topics of differential and integral calculus, followed by advanced integration techniques using partial fractions, trigonometric functions, integration by parts, and indefinite integrals. Students study first order differential equations, parametric equations, polar graphs, and infinite series. Students will be expected to sit for the BC Advanced Placement Exam.

- Prerequisite: AP Calculus AB and permission of the department

AP STATISTICS

How is data collected? How is it described? What, if anything, do these descriptions mean? These are the central questions of statistics. This rigorous, year-long course will focus on the descriptions of one and two variable data and the inferences that can be drawn from them. We will address such topics as: study design and bias, sample surveys, the normal distribution, correlation, linear and non-linear regression, probability, confidence intervals, and tests of significance. Second semester, you will have the opportunity to pull all of these ideas together in a research project of your choice. You will develop your own research question, collect the data, display and summarize the data, and draw inferences from the data. Effective and precise technical and verbal communication of statistical concepts will be emphasized throughout the year, as we prepare for the Advanced Placement Examination in May.

- Prerequisite: Inferential Statistics, or Adv Algebra & Precalculus, or Precalculus-B

FALL SEMESTER COURSES

AP COMPUTER SCIENCE

This is a first course in computer science and requires no prior computer or programming experience. Using the Java programming language, we will explore computer science fundamentals such as data types, logical operators, control statements, arrays, recursion, sorting, and searching. In addition, we will focus on the larger architecture of program design, that is, how do you design a program to effectively model a physical situation or answer a given research question. By studying object-oriented design, we will see how to create self-contained, reusable objects that call each other in order to carry out different tasks. In addition to becoming fluent in a new language (Java), you will have ample opportunity to develop and apply your creativity and your logical reasoning skills. You will design and write your own programs, both text-based and graphical. These will include chatbots, a card game, and an image manipulation project. In May, all students will sit for the Computer Science A - AP Exam. A laptop (Mac or PC) is required for this course. Any student who cannot bring a laptop may be given a loaner laptop from the school. Please contact the academic dean.

- Prerequisite: a grade of B+ in Math III or Adv Algebra & Precalculus, or permission of current math teacher

NON-EUCLIDEAN GEOMETRY AND SPECIAL RELATIVITY

This curious little class will be a hitchhiker's guide to Book I of Euclid's Elements. We will travel through each one of the 48 propositions—more or less in order—and see how each one of them generalizes (or does not generalize) to hyperbolic, elliptic, and other non-Euclidean and higher dimensional spaces. (Yes, we will travel to the fourth dimension... and beyond!) As we progress through Euclid's propositions, it will become increasingly clear that every theorem in neutral and hyperbolic geometry can be translated into a true statement in Einstein's Special Theory of Relativity. Topics will include curved space, time as a higher dimension, relativity, time travel, and the shape of space-time.

- Prerequisite: Adv Algebra & Precalculus, or Precalculus-B

SPRING SEMESTER COURSES

INTRODUCTION TO CHAOS THEORY AND FRACTAL GEOMETRY

"Does the flap of a butterfly's wings in Brazil set off a tornado in Texas? If you smiled at your mother this morning, does it have global consequences?" So asked Edward Lorenz, a meteorologist at MIT in the early 1960s, and thus a new branch of mathematics was born. Chaos Theory studies the behavior of dynamical systems that are highly sensitive to initial conditions, a situation which is popularly referred to as the "butterfly effect." Small differences in initial conditions yield widely diverging outcomes for such dynamical systems, rendering long-term prediction impossible. This happens even though these systems are deterministic, meaning that their future behavior is fully determined by their initial conditions, with no random elements involved. In other words, the deterministic nature of these systems does not make them predictable. This was summarized by Edward Lorenz as follows: "Chaos: when the present determines the future, but the approximate present does not approximately determine the future." Chaotic behavior can be observed in many systems, such as the weather, the stock market, galaxies, clouds, snowflakes, bluebells, dripping faucets, trees, heartbeats, political elections, and seashells.

- Prerequisite: Adv Algebra & Precalculus, or Precalculus-B