AP Calculus AB

Official Syllabus

Haddonfield Memorial High School

Contents:

Curricular Requirements

CR1a	The course is structured around the enduring understandings within Big Idea 1: Limits.
CR1b	The course is structured around the enduring understandings within Big Idea 2: Derivatives.
CR1c	The course is structured around the enduring understandings within Big Idea 3: Integrals and the Fundamental Theorem of Calculus.
CR2a	The course provides opportunities for students to reason with definitions and theorems.
CR2b	The course provides opportunities for students to connect concepts and processes.
CR2c	The course provides opportunities for students to implement algebraic/computational processes.
CR2d	The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.
CR2e	The course provides opportunities for students to build notational fluency.
CR2f	The course provides opportunities for students to communicate mathematical ideas in words, both orally and in writing.
CR3a	Students have access to graphing calculators.
CR3b	Students have opportunities to use calculators to solve problems.
CR3c	Students have opportunities to use a graphing calculator to explore and interpret calculus concepts.
CR4	Students and teachers have access to a college-level calculus textbook.

AP Calculus AB Syllabus

Prerequisites

Successful completion of the following yearlong courses:

1. Algebra 1
2. Geometry (includes analytic geometry)
3. Algebra 2 (includes logarithms)
4. Precalculus (includes elementary functions and trigonometry)

Content Outline

- I. Limits and Continuity [CR1a]
  1. Evaluating limits
     - a. Limits evaluated from tables
     - b. Limits evaluated from graphs
     - c. Limits evaluated with technology
     - d. Limits evaluated algebraically
       - i. Algebraic techniques
       - ii. The Squeeze Theorem
     - e. Limits that fail to exist
  2. Limits at a point
     - a. Properties of limits
     - b. Two-sided limits
     - c. One-sided limits
  3. Continuity
     - a. Defining continuity in terms of limits
     - b. Discontinuous functions
       - i. Removable discontinuity
       - ii. Jump discontinuity
       - iii. Infinite discontinuity
     - c. Properties of continuous functions
       - i. The Intermediate Value Theorem
       - ii. The Extreme Value Theorem
  4. Limits involving infinity
     - a. Asymptotic behavior
     - b. End behavior
- II. Differential Calculus [CR1b: derivatives]
  1. Introduction to derivatives
     - a. Average rate of change and secant lines
     - b. Instantaneous rate of change and tangent lines
     - c. Defining the derivative as the limit of the difference quotient
     - d. Approximating rates of change from tables and graphs
  2. Relating the graph of a function and its derivative

3. Differentiability
    a. Relationship between continuity and differentiability
    b. When a function fails to have a derivative
4. Rules for differentiation
    a. Polynomial and rational functions
    b. Trigonometric functions
    c. Exponential and logarithmic functions
    d. Inverse trigonometric functions
    e. Second derivatives
5. Methods of differentiation
    a. The chain rule
    b. Implicit differentiation
    c. Logarithmic differentiation
6. Application of derivatives
    a. Velocity, acceleration, and other rates of change
    b. Related rates
    c. The Mean Value Theorem
    d. Increasing and decreasing functions
    e. Extreme values of functions
    f. Local (relative) extrema
    g. Global (absolute) extrema
    h. Concavity
    i. Modeling and optimization
    j. Linearization
    k. L'Hopital's Rule

III. Integral Calculus

1. Antiderivatives and indefinite integrals
2. Approximating areas
    a. The rectangle approximation method
    b. Riemann sums
    c. The trapezoidal rule
3. Definite integrals and their properties
4. The Fundamental Theorem of Calculus
    a. The First Fundamental Theorem of Calculus
    b. The Second Fundamental Theorem of Calculus
    c. The Mean Value Theorem for integrals
    d. Average value of a function
5. Methods of Integration
    a. Algebraic manipulation
    b. Integration by substitution
6. Solving differential equations
    a. Separation of variables
    b. Slope fields
7. Applications
    a. Exponential growth and decay
    b. Particle motion

c. Area between two curves
d. Volumes
    i. Volumes of solids with known cross sections
    ii. Volumes of solids of revolution

Mathematical Practices

I. Reasoning with definitions and theorems
In problems where students practice applying the results of key theorems (i.e. – IVT, MVT, etc.), students are required for each problem to demonstrate verbally and/or in writing that the hypotheses of the theorems are met in order to justify the use of the appropriate theorem. For example, in an in-class activity, students are given a worksheet that contains a set of functions on specified domains on which they must determine whether they can apply the Mean Value Theorem. There are cases where some of the problems do not meet the hypotheses in one or more ways. [CR2a]

II. Connecting concepts and processes
Students are provided with the graph of a function and a second function defined as the definite integral of the graphed function with a variable upper limit. Using differentiation and antidifferentiation, students evaluate specific values of the second function and then find the intervals where the integral function is increasing, decreasing, concave up, and concave down. They use this information to sketch a rough graph of the second function. [CR2b, CR2d]

III. Implementing algebraic/computational processes
Students are presented with a table of observations collected over time periods of different lengths. Students use Riemann sums to numerically approximate the average value of the readings over the given time period and interpret the meaning of the value. [CR2c, CR2d]

IV. Connecting multiple representations
Students are presented with numerous functions modeling velocity and time for objects in motion. These functions are presented numerically, graphically, analytically, and verbally. Many of these functions are distinct, but some represent the same function. Given some initial conditions, students calculate or approximate displacement, total distance travelled, and acceleration for these functions, and determine which representations are the same function. Students evaluate how each representation was useful for solving the problems. [CR2d, CR3b]

V. Building notational fluency
Students are given a variety of growth and decay word problems where the rate of change of the dependent variable is proportional to the same variable (i.e. – population growth, radioactive decay, continuously compounded interest). Students are asked to translate the problem situation into a differential equation using proper notation. Students show the steps in solving he differential equation, continuing to use proper notation for each step. In a later activity, students will vary initial conditions and use their calculators to graph the resulting solutions so that students can explore the effect of these changes. [CR2e, CR3c]

VI. Communicating

VII. Throughout the course, students are required to present solutions to homework problems both orally and on the board to the rest of the class. On at least one question on each quiz and test, students are explicitly instructed to include clearly written justifications in complete sentences for their solutions. [CR2f]

Course Materials

Textbook:

Larson, Ron and Paul Battaglia. *Calculus for AP*. Boston: Cengage, 2017. [CR4]

Included with this textbook is access to WebAssign for additional practice and support.

Calculator:

A TI-83 or TI-84 Graphing Calculator is required of all students. Use of the calculator by students to solve problems includes, but is not limited to, plotting and analyzing the graphs of functions within an arbitrary viewing window, finding the zeros of functions, finding the limits of a function at a specific value, and analytically and numerically calculating both the derivative of a function and the value of a definite integral.

Another major use of graphing calculators is in labs to discover some of the concepts and principles at work by experimenting with the various function representations and approaches to their solutions. [CR3a]

Supplemental Materials:

Lederman, David. *Multiple Choice & Free-Response Questions in Preparation for the AP Calculus (AB) Examination*. 9th ed. Brooklyn: D & S Marketing Systems, Inc., 2011.