# Advanced Placement Calculus AB Syllabus

## Prerequisites

Successful completion of the following yearlong courses:

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

## Curricular Requirements

An outline of the topics discussed and practiced in the course.

I. Limits and Continuity
   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
   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. Applications 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. Newton's method
    l. L'Hospital'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

The following is a brief description of some of the activities included in the course.

I. Reasoning with definitions and theorems

1.2B - In problems where students practice applying the results of key theorems (e.g., Intermediate Value Theorem, Mean Value Theorems, and/or L'Hospital's Rule), 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.

II. Connecting concepts and processes

3.3A - 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.

III. Implementing algebraic/computational processes

3.2B - Students are presented with a table of observations collected over time periods of different lengths (e.g., temperatures or stock prices). Students use Riemann sums to numerically approximate the average value of the readings over the given time period and interpret the meaning of that value.

IV. Connecting multiple representations

2.3C - Students are presented with numerous functions modeling velocity and time for objects in motion. These functions are presented numerically, graphically, analytically (in the form of a formula), and verbally (as a description in words of how the function behaves). Many of these functions are distinct, but some represent the same function (e.g., one of the functions presented verbally is the same as one of the functions presented analytically). Given some initial conditions, students calculate or approximate displacement, total distance travelled, and acceleration for these functions (both by hand and with a graphing calculator), and determine which representations are the same function. Students evaluate how each representation was useful for solving the problems.

V. Building notational fluency

3.5B - 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 (e.g., population growth, radioactive decay, continuously compounded interest, and/or Newton's law of cooling). Students are asked to translate the problem situation into a differential equation using proper notation. Students show the steps in solving the differential equation, continuing to use proper notation for each step (e.g., when to keep or remove absolute value). 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.

VI. Communicating

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.

## Course Materials

### Textbook

Larson, Ron and Bruce H. Edwards. *Calculus: Early Transcendental Functions*. AP Edition. 6th ed. Boston: Brooks/Cole, 2015.