

# Advanced Placement Calculus BC Syllabus

## Course Description

The primary goal of this course is to prepare a student for higher-level math wherever the student attends college the year following the course. The secondary goal of this course is to cover the material in the course description provided by the College Board for Advanced Placement Calculus BC. This course will require a high level of commitment and time from the student to be successful. It is approximately equal to 2 semesters of college-level engineering calculus.

While students are not required to take the Advanced Placement test in May, they are strongly encouraged to do so. Any student who elects not to take the AP Exam will be required to take an AP style Final Exam, regardless of other incentives which may be offered to seniors based on grades or attendance. Therefore students should approach the course with a degree of seriousness beyond that of most other courses they have taken or are taking.

The recognition of the major elements of calculus as interconnected parts of the course is vital. These elements are limits, derivative, integrals, and polynomial approximation. In fact, it is a major goal that students will see and appreciate the relationships between these ideas, their usefulness in scientific and other applications, and to see how they relate to other fields of study. To this end, students will learn and use the “Rule of Four”, which is the ability to analyze and communicate ideas analytically (algebraically) [SC7], graphically (by hand or using technology) [SC5], numerically (by hand or using technology) [SC6], and verbally (including written form) [SC8, SC9]. At times students will be encouraged to solve a problem using multiple representations in order to enhance their learning. Assessment will include using all four modes, with some problems requiring the use of technology (graphing calculator), and some which require the students to work by hand.

SC7–The course provides students with the opportunity to work with functions represented analytically.

SC5–The course provides students the opportunity to work with functions represented graphically.

SC6–The course provides students with the opportunity to work with functions represented numerically.

SC8–The course provides students with the opportunity to work with functions represented verbally.

SC9–The course teaches students how to explain solutions to problems orally.

## Primary Textbook

Finney, Ross L., Franklin Demana, Bert Waits, and Daniel Kennedy. *Calculus: Graphical, Numerical, Algebraic*. Reading, Mass.: Addison-Wesley, 2007.

# Course Outline

The chapter numbers below follow the textbook.

## Chapter 1: Prerequisites for Calculus (2 blocks) [SC1]

- Graphs and models
- Linear models and rates of change
- Functions and their graphs
- Fitting models to data
- Inverse functions
- Exponential and logarithmic functions

## Chapter 2: Limits and Continuity (5 blocks) [SC1]

- Limits:
  - Limit at a point, limit at infinity, infinite limits
  - Properties of limits
- Continuity
- Tangent line to a curve
- Slope of a curve at a point

## Chapter 3: Derivatives (7 blocks) [SC2]

- Definition of  $f'$  [SC7]
- Derivative at a point
- Relating the graphs of  $f$  and  $f'$  [SC5]
- When does  $f'(a)$  fail to exist?
- Rules for differentiation:
  - Sum, product, quotient [SC7]
- Chain rule
- Implicit differentiation
- Derivatives of trigonometric, inverse trigonometric, exponential, and logarithmic functions

## Chapter 4: Applications of Derivatives (8 blocks) [SC2]

- Mean value theorem
- Using the derivative to find:
  - Critical point(s) and extreme values
  - When the function is increasing or decreasing
  - Point(s) of inflection
  - When the function is concave up or concave down
- Optimization problems
- Using the tangent line to approximate function values
- Newton's method
- Differentials and change
- Related rates

SC1–The course teaches all topics associated with Functions, Graphs, and Limits as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description.

SC2–The course teaches all topics associated with Derivatives as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description.

SC7–The course provides students with the opportunity to work with functions represented analytically.

SC5–The course provides students the opportunity to work with functions represented graphically.

SC3–The course teaches all topics associated with Integrals as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description.

### Chapter 5: The Definite Integral (7 blocks) [SC3]

- RAM (rectangle approximation method)
- Riemann sums
- Finding a formula for an antiderivative [SC7]
- Using a definite integral to find area, volume, average value of a function
- Fundamental theorem of calculus
- Approximating the definite integral:
  - Trapezoidal rule, Simpson's Rule, error analysis

SC7–The course provides students with the opportunity to work with functions represented analytically.

### Chapter 6: Differential Equations and Mathematical Modeling (7 blocks)

- Slope fields [SC5]
- Antiderivatives and the indefinite integral
- Techniques of integration:
  - Substitution, integration by parts, trigonometric substitution, partial fractions [SC7]
- Separable differential equations
- Euler's method
- Exponential growth and decay
- Logistic growth

SC5–The course provides students the opportunity to work with functions represented graphically.

### Chapter 7: Applications of Definite Integrals (6 blocks) [SC3]

- Using the definite integral to discuss:
  - Net change – motion on a line, consumption over time [SC8]
  - Area, volume, length of a curve, surface area of a solid of revolution
  - Work, fluid force [SC8]

SC8–The course provides students with the opportunity to work with functions represented verbally.

### Chapter 8: L'Hôpital's Rule, Improper Integrals, Partial Fractions (7 blocks) [SC3]

- Indeterminate forms ( $\frac{0}{0}, \frac{\infty}{\infty}, \infty - \infty, 1^\infty, 0^0, \infty^0$ ) and L'Hôpital's rule
- Relative rates of growth
- Improper integrals (partial fractions and trig substitutions – done with Chapter 6)

### Chapter 10: Parametric, Vector, and Polar Functions (7 blocks) [SC1]

- Parametric functions:
  - Derivative at a point
- $\frac{d^2y}{dx^2}$ 
  - Length of a curve, surface of a solid of revolution
- Vectors:
  - Angle between two vectors
  - Scalar product
  - Using vectors to describe motion in the plane

SC1–The course teaches all topics associated with Functions, Graphs, and Limits as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description.

SC4–The course teaches all topics associated with Polynomial Approximations and Infinite Series as delineated in the Calculus BC Topic Outline in the AP Calculus Course Description.

- Polar coordinates and pole graphs
  - Slope, horizontal and vertical tangent lines
  - Area, length of a curve

### Chapter 9: Infinite Series (8 blocks) [SC4]

- Geometric series
- Power series
  - Term-by-term differentiation and integration to find power series of new functions [SC7]
- Taylor's series/Maclaurin series
- Lagrange form of the remainder
- Tests for convergence/divergence:
  - $n^{\text{th}}$  term test
  - Direct comparison
  - Ratio test
  - Integral test
  - Limit comparison test
  - Alternating series test (Leibniz's theorem)
- Radius and interval of convergence

SC7–The course provides students with the opportunity to work with functions represented analytically.

SC10–The course teaches students how to explain solutions to problems in written sentences.

### Review for AP Exam

- Practice Multiple Choice problems (from released exams) will be done in class, outside of class, some for a grade, and some just for practice
- Practice Free Response problems (from released exams and from the AP Central Web Site) will be done in class, outside of class, some for a grade, and some for just practice. Students are encouraged to talk to each other, but are supposed to prepare their own solutions in well-written sentences. [SC10]
- Special emphasis will be given to strategies in answering questions efficiently with proper use of time, and which questions on the Calculator Active sections will actually require the calculator and which will not.

## Technology

Significant use is made of the graphing calculator, primarily TI-83 and TI-84 models, though students have the option of using a different calculator if they are willing to learn its features on their own. Students use programs in their calculators to: [SC11, SC12, SC13]

- Investigate limits of functions
- Confirm characteristics (e.g. concavity) of graphs of functions
- Perform numerical integration
- Find points of inflection
- Show Riemann sums
- Compute partial sums
- Use Euler's method
- Show a slope field

SC11–The course teaches students how to use graphing calculators to help solve problems.

SC12–The course teaches students how to use graphing calculators to experiment.

- Draw a solution curve on a slope field
- Sketch implicitly defined functions.

SC13–The course teaches students how to use graphing calculators to interpret results and support conclusions.
--

## Student Evaluation

Grades are determined using homework, quizzes, graded worksheets, tests, projects, and practice AP Exam questions. Homework that is graded is a subset of the entire homework assignment called “Circle Problems” because they are circled on the student’s assignment sheet. This allows the instructor to find common mistakes and misconceptions and address them with the class. Many worksheets contain old AP Questions from Released Exams or the Free Response Questions on the AP Central web site. All work contains a combination of analytical (algebraic) work and calculator work. The First Semester Exam is an AP style exam containing both Multiple Choice and Free Response questions, some of each using the calculator and some without. These are graded with the same rubrics and scoring as an actual AP Exam and an AP score is generated as well as a percentage for our school’s usage.