

AP Calculus BC course syllabus

Philosophy of course:

Students who complete the Calculus BC curriculum should have received the equivalent courses of what is typically referred to as Calculus I and Calculus II at most college campuses. The material covered should be comparable and the rigor of the course should be equivalent to the college courses. It is expected of the students who take this course to take the College Board Advanced Placement test for Calculus BC at the end of the course.

Textbook used

Calculus, eighth edition by Ron Larson, Robert Hostetler and Bruce Edwards. Published by Houghton Mifflin Company

Supplemental material include (but is not limited to) The Calculus by Louis Lethhold (4th edition), Calculus, Graphical, Numerical, Algebraic by Finney, Demana, Waits, and Kennedy (3rd edition – AP edition), Calculus Concepts and Applications by Paul Foerster, and materials gathered from attending Advanced Placement conferences over the years.

Topics Covered:

Chapter P: Preparation for Calculus (five days)

Although many Calculus BC classes do not spend time on the prerequisite chapter, I normally include the first week of school on the material from this chapter for students to get use to rigors of the class, to refresh their memory of previous math knowledge and verify that the students possess the prerequisite skills needed. Topics for this chapter include a basic review of functions and graphs, linear models and rates of change as well as a brief review of trigonometry.

Chapter One: Limits and Their Properties (10 days)

- Finding limits graphically and numerically: Intuitive approach to limits by studying graphs and charts from calculators and/or computer applications
- Formal definition of limit ($\delta - \epsilon$) including proofs of limits of linear functions
- Properties of limits
- Techniques for evaluating limits analytically
- Continuity and properties of continuity
- The Intermediate Value Theorem
- One sided limits and applications to continuity
- Infinite limits

Chapter Two: Differentiation (15 days)

- Definition of the derivative
- Relating the graph of a function with the derivative
- Non-differentiability
- Basic differentiation rules
- Rates of change

- The Product Rule and Quotient Rule
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- Derivatives of trigonometric functions
- Higher order derivatives
- The Chain Rule
- Implicit Differentiation
- Related rates
- Rectilinear motion

Chapter Three: Applications of Differentiation (20 days)

- Extrema on a closed interval and critical points
- Rolle's Theorem
- The Mean Value Theorem
- Increasing and decreasing functions and the First Derivative Test
- Concavity and the Second Derivative Test
- Limits at infinity (horizontal asymptotes, slant-asymptotes and other "end behavior").
- Putting it all together with curve sketching
- Optimization problems
- Newton's method
- Differentials

Chapter Four: Integration (15 days)

- Definition of antiderivative and basic integration rules
- Initial conditions and particular solutions
- Area approximation using rectangles
- Riemann sums and the definite integral
- The Fundamental Theorem of Calculus
- The definite integral as net change
- Integration by substitution (both with definite and indefinite integrals)
- Approximating definite integrals using trapezoid rule and Simpson's rule

Chapter Five: Logarithmic, Exponential, and other transcendental functions (10 days)

- Defining a function as a definite integral
- The natural logarithmic function: definition and properties
- The derivative of logarithmic functions (including other logarithmic functions as well as the natural logarithmic function)
- Logarithmic differentiation
- Integration involving the logarithmic function
- Investigation of inverse functions and the derivative of inverse functions at a point
- Derivatives and integrals of exponential functions including bases other than e.
- Derivative and integrals of inverse trigonometric functions

Chapter Six: Differential Equations (8 days)

- Slope fields
- Euler's Method

- Growth and Decay models
- Solving differential equations with variable separation
- The Logistic Equation

Chapter Seven: Applications of Integration (15 days)

- Using integrals to find area under a curve or between two curves
- Finding volume of solids of revolution using the disk method, washer method and the shell method
- Finding volumes of solids of known cross sections
- Finding arc length of curves and surface area of solids of revolution
- Work and fluid pressure and fluid force application problems

Chapter Eight: Integration techniques, L'Hôpital's rule, and Improper Integrals (15 days)

- Review of basic integration rules
- Integration by parts
- Trigonometric integrals
- Integration using trigonometric substitution
- Integration using partial fraction decomposition
- Other miscellaneous integration techniques
- Applying L'Hôpital's rule to indeterminate forms of limits
- Investigating the convergence and divergence of improper integrals

Chapter Nine: Infinite Series (20 days)

- Sequences and limits of sequences
- Tests for convergence and divergence of series using the following tests (and error analysis where appropriate)
 - Geometric series test
 - Telescoping series
 - The nth test for divergence
 - The Integral test
 - P-series
 - The direct comparison test
 - The limit comparison test
 - Alternating series
 - The ratio test
 - The root test
- Taylor Polynomials and Maclaurin polynomials and series to approximate functions (including error analysis)
- Power series
- Radius of convergence and intervals of convergence

Chapter Ten: Parametric equations and Polar coordinates (8 days)

- Defining a function parametrically and eliminating the parameter
- Find the first and second derivative (with respect to x) of a parametrically defined function
- Finding arc length and area of a surface of revolution using parametrics
- Polar equations and graphs
- Tangent lines to polar equations, area of polar regions and arc length of polar graphs

Chapter Eleven and Twelve: Vectors (10 days)

- Component form of vectors
- Basic vector operations
- Space coordinates and vectors in space
- Vector valued functions
- Differentiation and integration of vector valued functions
- Velocity and acceleration vectors
- Tangent and normal vectors
- Arc length of plane and space curves

Review for the Advanced Placement Exam

Throughout the school year, practice AP questions from previous school years are reviewed. These reviews will cover any previously studied section and are not limited to the section being covered at that time period. Every test given in the course included Advanced Placement type questions both multiple choice and free response. Students are offered a practice AP exam (in a testing environment) on a Saturday and on online practice they can take at home. Review for the Advanced Placement exam is focused the last couple of weeks before the test, but really is a year long process. Both non-calculator and calculator type questions are reviewed.

Discussion and writing in the Calculus class

- Students are expected to be able to explain work and concepts both in writing on quizzes, tests and homework as well as verbally in class.
- Students are expected to analyze “real world” situations and apply calculus concepts to evaluate or solve problems
- The students have an online bulletin board to discuss homework questions and calculus concepts. Although I do moderate the board for correctness of explanations and appropriateness, the board is mainly student controlled.
- Peer tutoring is encouraged and opportunity for group work is given using both class time and out of class time.

Calculator and computer use

A graphing calculator is required for this class. If a student cannot afford a calculator, an arrangement can be made for the student to borrow a calculator for the class. The student is expected to know how to efficiently use the calculator to investigate functions, derivatives and integrals. The student should be able to deal with tables of values to approximate rates of change or accumulated change over time intervals. Calculator use on tests and quizzes are limited to when appropriate, but use in class and homework is always allowed to help the student further understand the concept through visualization.. Students are also expected to be able to apply computer tools to help explore Calculus concepts including but not limited to spreadsheet programs and online symbolic integration and differentiation programs.

Student Evaluation

Regular homework and participation in class discussion is expected of all students. Quizzes and tests are given regularly to assess understanding. Students are expected to clearly

show their work and justify answers on quizzes, test and homework. Students are also expected to verbally explain problems and concepts.

Students are expected to incorporate a variety of methods for solving problems including graphical, numerical, and analytical investigations. They should be able to justify reasonableness of answers and provide appropriate approximations.