

AP Calculus AB Course Outline

Prerequisite: Satisfactory completion of: Geometry, Algebra II, and Pre-calculus

Advanced Placement Calculus AB is designed as college-level Calculus I. Students are required to take the College Board AB Examination in May to determine college credit awarded. Extensive use of a graphing calculator will be a major requirement of this course. Students and teachers will use technology regularly, to reinforce the relationship among the multiple representations of functions, to confirm written work, to implement experimentation, and to assist in interpreting results. Homework assignments will be enhanced by the use of the graphing calculator and many colleges require students to own a graphing calculator and be well trained in its use. Purchase of a graphing calculator is still a personal choice – a TI-83Plus or TI-89 is recommended; be advised a graphing calculator with certain features is assumed when taking the AP exam.

The Exam:

The [Advanced Placement Calculus Test \(AB\)](#) given the first week of **May**. The test will consist of 45 multiple-choice questions, most involving some computation, and 6 free-response questions, equally weighted. For 28 multiple-choice questions in 55 minutes, no calculator is allowed. For the other 17 multiple-choice questions in 50 minutes and the first half of the free-response section (45 minutes), a graphing calculator with certain features is assumed. For the second half of the free-response section (45 minutes), the calculator will no longer be permitted. Total test time is three hours and fifteen minutes. The free-response questions are scored on content and presentation of the solution and the scores for both parts are combined to produce a raw score and then an index from 1 (no recommendation) to 5 (extremely well-prepared). Most colleges and universities will grant one semester's credit for a score of 3 or better. All are expected to take the Advanced Placement Calculus Test, although a fee of \$84 is required. Either the Calculus AB or Calculus BC can be taken—not both.

This outline of topics is intended to indicate the scope of the course, but it is not necessarily the order in which the topics are to be taught. The time spent is only an estimate of the average number of days allotted to the topic. Actual time varies from year to year depending on the students' abilities and interests. Although the examination is based on the topics listed in the topical outline, enrichment topics are included in this course.

Review of Prerequisites/ Analysis of graphs, 2 weeks, Chapter P

1. Real Numbers and the Real Line
2. The Cartesian Plane
3. Graphs of Equations - With the aid of technology, graphs of functions are often easy to produce. The emphasis is on the interplay between the geometric and analytic information and on the use of calculus both to predict and to explain the observed local and global behavior of a function.
4. Lines in the Plane
5. Functions –including:

- a) Identify graphs of the following functions: constant, linear, quadratic, cubic, square and cube root, absolute value, greatest integer, exponential, logarithmic, and trigonometric
 - b) Domain, range, intercepts, symmetry, asymptotes, zeros, and odd and even function
 - c) Shifts, reflections, stretches, and shrinks
 - d) Relations, functions, and their inverses
6. Trigonometric Function Review

Limits and Their Properties, 3 weeks, Chapter 1

- 1. An intuitive understanding of the limiting process
- 2. Instantaneous Velocity
- 3. Finding limits algebraically
- 4. Continuous functions
- 5. Determine when a limit does not exist
- 6. Evaluate one-sided limits
- 7. Limits involving infinity
- 8. Asymptotic and unbounded behavior
- 9. Understanding asymptotes in terms of graphical behavior
- 10. Describing asymptotic behavior in terms of limits involving infinity
- 11. Geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem).

Derivatives 4 weeks, Chapter 2

Concept of the derivative

- 1. The concept of the derivative presented geometrically, numerically, and analytically
- 2. Derivative defined as the limit of the difference quotient
- 3. Slopes, tangent lines, and derivatives
- 4. Differentiation Rules
- 5. Velocity, Speed, and Other Rates of Change
- 6. Determine the derivative of a function in a variety of ways including slope of the tangent line, rate of change of the function, and instantaneous velocity
- 7. Derivatives of Trigonometric Functions
- 8. Derivatives of Logarithmic and Exponential Functions
- 9. Relationship between differentiability and continuity
- 10. Slope of a curve at a point
- 11. Chain Rule, Product Rule, Quotient Rule
- 12. Higher-Order Derivatives
- 13. Implicit Differentiation and Fractional Powers
- 14. Instantaneous rate of change as the limit of average rate of change.

Applications of derivatives 5 weeks, Chapter 3

- 1. Curve sketching involving derivatives and sign lines
- 2. Rolle's Theorem and the Mean Value Theorem

3. Use the First Derivative Test to find the intervals on which a function is increasing and decreasing and to determine relative extrema of a function
4. Use the Second Derivative Test to determine intervals of concavity of a function and locate inflection points
5. Corresponding characteristics of graphs and the relationship between the increasing and decreasing behavior of f and the sign of f'
6. Corresponding characteristics of the graphs and the relationship between the concavity of f and the sign of f''
7. Points of inflection as places where concavity changes
8. Optimization, both absolute (global) and relative (local) extrema
9. Modeling rates of change, including related rates problems.
10. Graphing summary including roots, domain and range, asymptotes, symmetry, extrema, and concavity
11. Optimization Problems
12. Newton's Method
13. Business and Economic Applications—extra-credit

Integration, 5 weeks, Chapter 4

1. Understand the concept of area under a curve using a Riemann sum over equal subdivisions
2. Use the limit of a Riemann sum to calculate a definite integral
3. Definite integrals and Antiderivatives
4. Fundamental Theorem of Calculus
5. Use the graphing calculator to compute definite integrals numerically
6. Techniques of antidifferentiation
7. Integration of trigonometric functions
8. Numerical Integration: Trapezoidal Rule and Simpson's Rule
9. Slope fields

Log, Exp, and Other Transcendentals, 6 weeks, Chapter 5

1. The Natural Logarithmic Function and Differentiation
2. The Natural Logarithmic Function and Integration
3. Inverse Functions
4. Exponential Functions: Differentiation and Integration
5. Bases Other than e and Applications
6. Differential Equations: Growth and Decay
7. Inverse Trigonometric Functions and Differentiation
8. Inverse Trigonometric Functions: Integration and Completing the Square
9. Hyperbolic Functions

Integration Applications, 3 weeks, Chapter 7

1. Use definite integrals to find the area under a curve
2. Use definite integrals to find the area of a Region Between Two Curves
3. Volume: The Disc and Washers Methods

4. Volume: The Shell Method
5. Arc Length and Surfaces of Revolution
6. Average Value of a Function
7. Volumes of solids with known cross sections
8. Work—extra-credit
9. Fluid Pressure and Fluid Force—extra-credit
10. Moments, Centers of Mass, and Centroids—extra-credit

Integration Techniques, 3 weeks, Chapter 8

1. Basic Integration Rules
2. Integration by Parts—especially important
3. Trigonometric Integrals
4. Trigonometric Substitution
5. Tables and Other Techniques
6. L'Hôpital's Rule
7. Improper Integrals

Grading:

- Tests: There will be a test at the conclusion of each chapter. Each test will be worth 100 points. There will be a non-calculator section and calculator section to every test.
- Quizzes: There will not be many regular quizzes. When we do have a quiz it will be worth 25 points. Expect a quiz on Chain Rule, Optimization, Slope Fields, and Volumes.
- Homework: Daily homework will be assigned every day. It will not be formally graded, unless students are not completing the homework. This is to prepare students for typical first and second year college math courses.
- THT: Take home tests (THT) are take home quizzes that review material throughout the course. Each THT is worth 20 points. Students will receive a THT every 2-3 weeks. You may work with others students. You must show work.
- Projects: Projects will be worth 30-40 points. There will be at least 4 projects.

References and Materials

Major Textbook

Larson, Hostetler, and Edwards Calculus 8th edition--2006, Houghton--Mifflin

Supplementary Materials

2006, 2007 AP Calculus AB and BC Course Description

AP Calculus Teacher's Guide

AP Calculus Free-Response Questions and Solutions 1989-1997

AP Calculus Free-Response Questions and Solutions 1969-1978

AP Calculus Multiple-Choice Question Collection 1969-1998

Hockett, Shirley O., How to Prepare for Advanced Placement Examinations in Mathematics, Barron's Educational Series

Lederman, David, Multiple Choice Questions in Preparation for the AP Calculus Examination
Technology Resources

MAA Reports--Resources for Calculus Collection. Washington, D.C.: MAA, 1993.

1. Learning by Discovery: A Lab Manual for Calculus
2. Calculus Problems for a New Century
3. Applications of Calculus
4. Problems for Student Investigation
5. Readings for Calculus

Edwards, Bruce Student Study and Solutions Guide, Volume I & II;

The Calculus Problem Solver, Staff of Research and Education Association

Stewart, James. Calculus. 5th edition. Belmont, CA: Brooks/Cole—Thomson Learning. 2003