

AP Calculus AB Course Syllabus

Overview

AP Calculus AB is equivalent to the first semester of single variable calculus offered at the college and university level. All topics outlined in the AP Calculus AB Course Description form the backbone of this class. Supplements include projects, graphing calculator activities, AP exam preparations and biographical readings. This content is integrated to help students form a foundation of conceptual knowledge to build future mathematical success upon, and to acquire an understanding of calculus that leads to competent performance on the AP Calculus exam. Holistic solution habits, clear communication skill, technological confidence, appreciation for the subject's evolution and the ability to connect these multiple domains are by products of course study.

Philosophy

A multirepresentational approach is utilized when presenting course topics. Concepts and problems are examined intuitively, graphically, numerically and analytically. Solutions are presented in clear, explicit fashion—orally and in writing. The ability to make connections among these representations and presentations is the main focus of instruction. Connecting number sense, visualization, modeling, processing and communication with the aid of technology forms a fundamental approach that can be used to solve any calculus problem regardless of context. Historical backgrounds from the lives of great calculus thinkers throughout time add an appreciation for the human element in this approach. Projects, activities, and homework assignments extend and challenge basic understanding.

Cooperative work groups are formed to reinforce this approach. Students are instructor-assigned to groups to balance ability and opportunity to interact. As the groups work, I walk around and listen; monitoring progress in representing, reasoning, accuracy, use of technology, connecting, and communicating. These components form the basis for course assessments. I make suggestions to the groups where improvement is needed, and use feedback to see how I can improve future lessons.

Technology Use

Graphing calculators are used in class on a daily basis. Students are encouraged to have an approved model for their own personal use. Extra units are available to insure daily access. For demonstration purposes, the TI-83 plus model from Texas Instruments is used. Students will develop the ability to:

1. graph a function within a specified viewing window
2. find the root of an equation
3. compute the numerical derivative of a function
4. numerically calculate a definite integral.

Additional instructional units are also used to enhance calculator skill. The units (from the Texas Instruments web site http://education.ti.com/education_portal/activity_exchange) are activity based and serve as excellent reinforcement for many course topics.

Study guides, step-by-step programs, exercises, solutions and curriculum alignment are included with each activity. Lessons can be found that cover:

1. Approaching limits
2. Graphing piecewise functions
3. Approximating integrals with Riemann Sums
4. Using slope fields
5. Local linearity
6. Definite integral applications
7. The Fundamental Theorem

For example, the “Approaching Limits” activity is an interactive unit that leads students to investigate function behavior as inputs approach a fixed value. Students work in groups, providing opportunities for cooperative learning. The primary learning objective is to have students state and explain limits at specified points for functions presented algebraically, graphically, and as a table of values. Each group collectively answers questions assigned from the activity hand out. Their work is graded on the assessment basics previously mentioned.

Projects, Readings

Enrichment takes the form of projects and readings. Projects are extended problems that often require technology to solve. Projects in the following contexts

- Escape velocity
- Vertical motion
- The shadow problem
- Quartic polynomials
- Speed and stopping distance
- Newton's Law of Cooling
- Mortgage amortization
- Archimedes Method of Exhaustion
- Fluid Force

are taken from extensions at the end of each unit from the major text.

Students work in cooperative groups on the projects assigned. The paper prepared is graded collectively on the accuracy of mathematics shown, the reasoning behind their conclusions, and the explicit nature of their communication. A statement demonstrating the connection of the project to the appropriate topic illustrated is expected with each paper.

Biographical readings are assigned where appropriate to highlight the human element of calculus. Each mathematician's achievement in historical context is presented and summarized. At selected times and after the AP exam the lives of Newton, Riemann, Leibniz, Archimedes, Cauchy, Euler, Agnesi, Bernoulli, Pascal and others are studied. Students are expected to prepare a short paper (4-5 paragraphs) that connects person, course topic, historical context, and achievement in other subjects. The result will be presented orally with the goal to illustrate the humanity behind an abstract idea.

Course Outline/Timeline

Unit 1 Review of Prerequisites (3 weeks)

- A. The real number system
- B. Coordinate geometry
- C. Functions and their inverses
 1. Linear functions
 2. Polynomial functions

- 3. Rational functions
- 4. Exponential and logarithmic functions
- 5. Trigonometric and inverse trigonometric functions
- 6. Piecewise functions
- D. Graphing functions
 - 1. Manually (t-charting)
 - 2. With technology
- E. The Unit Circle
 - 1. Trigonometric function values for standard radian values

Unit 2 Limits and Continuity (3 weeks)

- A. Rate of change
 - 1. Average rate of change
 - 2. Instantaneous rate of change
- B. Function limits
 - 1. Properties of limits
 - 2. Determining limits
(Intuitively, numerically, graphically, and algebraically)
 - 3. One and two sided limits
- C. Limits involving infinity
 - 1. Infinite limits
 - 2. Limits at infinity
 - 3. Asymptotic implications
- D. Continuity
 - 1. Intuitively defined
 - 2. Defined using limits
 - 3. Discontinuous functions
 - 4. Intermediate Value Theorem
 - 5. Extreme Value Theorem

Unit 3 The Derivative (5 weeks)

- A. Limit definition of the derivative
- B. The tangent line problem and local linearity
- C. Determining derivatives (intuitively, numerically, graphically and algebraically)
- D. Relationship of continuity and differentiability
- E. Basic differentiation rules and rates of change
- F. Differentiating combined functions
- G. The chain rule
- H. Implicit differentiation
- I. Derivatives of trigonometric functions and their inverses

J. Derivatives of logarithmic and exponential functions

Unit 4 Derivative Applications (5 weeks)

- A. Analyzing function behavior
 - 1. Critical values
 - 2. Increasing and decreasing intervals
 - 3. Determining extrema
 - a. maximum vs. minimum
 - b. absolute vs. relative
 - 4. Concavity and points of inflection
 - 5. Relating f , f' and f''
 - 6. Justifying extrema
 - a. Maximum vs. minimum
 - b. Second derivative test
 - c. Absolute vs. relative considerations
- B. Motion analysis (position, velocity, acceleration)
- C. Optimization models
- D. Related Rate Problems
- E. Mean Value Theorem
 - a. Rolle's Theorem
- F. L'Hopital's Rule

Unit 5 Definite Integrals (5 weeks)

- A. Interpretations
 - 1. Limit of Riemann sum
 - 2. Accumulated rates of change
- B. The Fundamental Theorem of Calculus
 - 1. Derivative—antiderivative relationship
 - 2. FTC—part one
 - 3. FTC—part two
- C. Properties of definite integrals
- D. Using to approximate area
 - 1. Interpreting (intuitively, algebraically, numerically and graphically)
 - 2. Riemann sums (left, right, mid)
 - 3. Trapezoid rule
 - 4. Approximation error
 - 5. Mean Value Theorem for Integrals

Unit 6 Antiderivative (9 weeks)

- A. Techniques
 1. Basic function antiderivatives
 2. Substitution of variables (u-substitution)
 3. Indefinite integrals
 4. Solving separable differential equations
- B. Applications
 1. Using initial conditions to find a particular solution
 2. Particle motion
 3. Growth and decay
 4. Population models
 5. Area of a region
 6. Volume of solids
 - a. the disk method
 - b. the washer method
 - c. the shell method
 - d. using known cross sections
- C. Numerical approximations to definite integrals
 1. Interpreting
 2. Riemann sum
 3. Trapezoid rule

The remainder of time is devoted to assessment and review. This timeline is flexible and can be adjusted to properly pace student understanding.

Assessment

Semester grades are composed of two quarter grades and a semester exam grade. Each quarter receives a 40% weight; the semester exam is weighed 20%. Test/quiz scores are weighed 80%, while the remaining composite from homework, extensions, activities and readings weigh 20%. Since all students are required to take the AP exam, a practice test is given during the fourth quarter to simulate the actual test experience. It is scored with the same scale used for the exam (free response/multiple choice weighting, 1-2-3-4-5 exam grade). Test and quizzes are constructed using many former AP problems from previously released exams.

Sources

The primary textbook used is Calculus with Analytic Geometry, 7th ed., by Larson, Hostetler and Edwards, Boston, Mass: Houghton-Mifflin, 2002. Homework exercises and extension projects are found in the text.

Secondary sources include:

Be Prepared for the AP Calculus Exam by Mark Howell and Martha Montgomery, Andover, Mass: Skylight Publishing, 2005.

Calculus Gems: Brief Lives and Memorable Mathematics by George F. Simmons, New York, New York: McGraw Hill, 1992.

Isaac Newton by James Gleick. New York, New York: Pantheon Books, 2003.