AP Calculus AB Course Outline

The following is an outline of the topics covered and a typical sequence in which those topics are covered. Please note the time spent is only an estimate of the average number of days allotted for each topic.

Semester 1

I. Limits and Continuity (3 weeks)

A. Limits at a point
1. Introduce limits intuitively
2. Direct substitution
3. Factor and use direct substitution
4. Estimate limits using table feature on calculator (TI-84+)
5. Visualize and estimate limits on graphs
6. Limit properties
7. One-sided limits
8 Presentation of definition of a limit to show how definition addresses "closeness"

B. Limits involving infinity
1. Asymptotic behavior
2. End behavior
3. Properties of limits
4. Limits with indefinite form
5. Visualize limits on graphs

C. Continuity
1. Continuous functions
   a. Intuitive approach
   b. Definition of continuity
2. Discontinuous functions
   a. Removable discontinuity-discontinuity at a point
   b. Jump discontinuity
   c. Infinite discontinuity
   d. One-sided continuity
3. Geometric properties of graphs on continuous functions
   a. Intermediate Value Theorem
   b. Extreme Value Theorem

II. Derivatives- presented graphically, numerically, analytically (9 weeks)

A. Definition of the derivative as limit of difference quotient

B. Average rate of change

C. Instantaneous rate of change as limit of average rate of change
   1. Slope of a curve at a point
   2. Tangent line to a curve at a point (including vertical tangents)

D. Differentiability
   1. Visualize local linearity
   2. Differentiability and continuity

E. Derivatives of algebraic functions-constant, sum/difference, constant multiple, power rules

F. Derivatives of trigonometric functions

G. Derivative rules for combining functions-product and quotient rules

H. Higher order derivatives
   1. Application to velocity and acceleration

I. Numeric derivatives using calculator

J. Implicit differentiation

K. Related Rates

L. Derivatives of exponential and logarithmic functions
   1. Logarithmic differentiation
      a. To simplify derivative problem
      b. To differentiate a function^{function}

M. Derivatives of inverse trigonometric functions

III. Applications of Derivatives-presented graphically, numerically, analytically (5 weeks)

A. Analysis of graphs and curve sketching
   1. Intervals where function is increasing or decreasing (with use of sign chart and use f' to verify)
      a. Locate critical points algebraically and with calculator graphically
   2. Relative (local) maximums and minimums and first derivative test
   3. Intervals where function is concave up or concave down (with use of sign chart and use f" to verify)
   4. Concavity and points of inflection
   5. Second derivative test for extrema
   6. Relationship among graphs of f, f', and f"
      a. Sketching
      b. Vary given function
      c. Use tables
   7. Mean Value Theorem
   8. Rolle's Theorem
   9. Absolute extrema on closed intervals

B Optimizations problems

C. Slope fields
   1. Discover the general behavior of a function that is a solution to a differential equation

IV. Semester Exam and Mock AP Test (1 week)

Semester 2

V. Integrals (9 weeks)

A. Approximate areas
   1. Riemann sums-right, left, midpoint
      a. Evaluate over region with equal subdivisions
      b. Evaluate over region with unequal subdivisions
   2. Trapezoidal approximation

B. General antiderivatives with emphasis on unknown constant
   1. Antiderivative formulas for algebraic, trigonometric, exponential, logarithmic functions
   2. Antiderivatives with substitutions

C. Fundamental Theorem of Calculus (Part 1)

D. Definite integral
   1. As limit of Riemann sums
   2. Techniques of integration (with substitutions-change limits of integration)
   3. Numerical approximations to definite integral using calculator, tables, and graphs

E. Fundamental Theorem of Calculus (Part 2)
   1. Use to evaluate definite integral
   2. Use to find specific antiderivative using initial conditions

F. Differential equations
   1. Solve separable differential equations including exponential growth and decay

VI. Applications of the Definite Integral (4 weeks)

A. Particle motion

B. Areas in a plane

C. Volumes
   1. Volumes with known cross sections
   2. Volumes of solids of revolution
      a. Disk method
      b. Shell method

D. Average value of a function

E. Accumulated change from a rate of change

F. Arc length

Philosophy and Strategies

Students that enroll in AP Calculus are primarily accelerated math students. They have already successfully completed Algebra, Geometry, Advanced Algebra/Trigonometry and Precalculus. Each student is required to have their own graphing calculator (the TI-84+ is preferred but some use a TI-83, TI-83+ or TI-89). I use a TI-84+ calculator and overhead. The calculator is used as a tool to illustrate ideas and topics, interpret results and/or support conclusions. For example, sketching a function in a specified window, finding a root of a function, approximating a derivative at a point and approximating a definite integral using numerical methods.

Students are taught that ideas can be investigated analytically, numerically and graphically. They are expected to relate the various representations to each other. It is important for them to understand that graphs and tables are no longer sufficient to prove an idea. An analytic argument is required when verifying a problem.

Communication is a goal of the course. Students are encouraged to work together and form study groups. They are expected to explain problems using proper vocabulary and terms. Students are expected on a daily basis to complete problems on the board and explain their solutions to their classmates. The emphasis is on students explaining and justifying their responses verbally and on their papers. This helps me know which students need extra help and which topics need to be re-taught. It also solidifies their ability to communicate mathematically both verbally and in writing.

Daily work, problem sets, quizzes and tests are given throughout the year. Students are often times required to work through and write up free-response problems that align with the current topic. Grades are taken on these and on selected work and problem sets based on the correctness of the mathematics and the written justification. Tests and quizzes also make up a large portion of the students grade. An overall grade is computed from total points accumulated over the course of a semester. The total points accumulated throughout the semester represent 80% of the semester grade while the final exam represents the remaining 20%.

Teacher Resources

Primary Textbook:

Larson, Roland E., Robert P. Hostetler, and Bruce H. Edwards. *Calculus with Analytic Geometry.* 6th ed. Boston: Houghton Mifflin, 1998.

Supplemental Resources:

Anton, Howard. *Calculus: A New Horizon, Brief Edition.* 6th ed. New York: John Wiley & Sons, Inc.

Finney, Ross L., Franklin D. Demana, Bert K. Waits, Daniel Kennedy. *Calculus: Graphical, Numerical, Algebraic.* 3rd ed. Boston: Pearson – Prentice Hall.

Weir, Maurice D., Joel Hass, Frank R. Giordano. *Thomas' Calculus – Early Transcendentals.* 11th ed. Boston: Pearson – Prentice Hall.