AP Calculus AB
Syllabus

Course Overview

The AP Calculus AB course at our school is taught over a full high school academic year. The primary textbook is *Calculus, Numerical and Algebraic*, by Finney, Demana, Waits, & Kennedy. However, many other resources are integrated throughout the course, as stated below. The primary goals of the course are to offer a sound and thorough understanding of Calculus concepts, in addition to adequately preparing students for success on the AP exam.

Throughout the course emphasis is placed on the "Rule of Four." There are a variety of ways to approach and solve problems. The four branches of the problem solving tree of mathematics are:

- Numerical analysis (where data points are known, but not an equation)
- Graphical analysis (where a graph is known, but again, not an equation)
- Analytic/algebraic analysis (traditional equation and variable manipulation)
- Verbal/written methods of representing problems (classic story problems as well as written justification of one's thinking in solving a problem)

Course Planner

Outlined below are the objectives and the sequence covered in the AP Calculus AB course, along with approximate time frames spent on each unit.

Functions, Graphs, and Limits

3 weeks

- Quick review of concepts related to a variety of functions and their graphs
- Properties of Limits
- Calculating Limits Algebraically as well as from Tables of Data and/or Graphs
- One-sided and Two-sided Limits
- Sandwich (or "Squeeze") Theorem

  A Graphical Exploration is used to investigate the Sandwich Theorem. Students graph y1 = x^2, y2 = -x^2, y3 = sin (1/x) in radian mode on graphing calculators. The limit as x approaches 0 of each function is explored in an attempt to "see" the limit as x approaches 0 of x^2 * sin (1/x). This helps tie the graphical implications of the Sandwich Theorem to the analytical applications of it.
- End Behavior Models
- Limits at Infinity and Relationships to Asymptotic Behavior
- Continuous Functions
- Intermediate Value Theorem

- Average and Instantaneous Rates of Change
- Tangent and Normal Lines to a Curve
- Slope of a Curve

Derivatives

7 weeks

- Definition of a Derivative
- Relationships between the graphs of *f* and *f'*
- Graphing the Derivative from a table of data and/or graph of the original function
- Local Linearity
  **An exploration is conducted with the calculator. Students graph y1 = absolute value of (x) + 1 and y2 = sqrt (x^2 + 0.0001) + 0.99. They investigate the graphs near x = 0 by zooming in repeatedly. The students discuss the local linearity of each graph and whether each function appears to be differentiable at x = 0
- Connections between Differentiability and Continuity
- Intermediate Value Theorem for Derivatives
- Rules of Differentiation (Power, Sum, Difference, Product and Quotient)
- Higher Order Derivatives
- Instantaneous Rates of Change
- Motion of a Particle
- Derivatives of Trigonometric Functions
- Simple Harmonic Motion
- Acceleration and Jerk
- Derivatives of Composite Functions
- Chain and Quotient Rules
- Power Chain Rule
- Implicit Differentiation
- Derivatives of Inverse Trigonometric Functions
- Derivatives of e^x, a^x, $\ln x$, $\log_a x$
- Derivatives on the calculator (Numerical derivatives using NDERIV)

Applications of Derivatives

4 weeks

- Relative and Absolute Extreme Values
- Mean Value Theorem
- Extreme Value Theorem
- Increasing and Decreasing Functions
- First Derivative Test
- Concavity of a Function

- Points of Inflection
- Second Derivative Test
- Connections between graphs of *f*, *f'* and *f''*

  Students will all be given 3 graphs of *f*, *f'*, and *f''* for different "classic" functions. Each student will have their own function and will have to explain written and verbally to the class the connection between *f*, *f'*, and *f''*. For example: when x<3, *f is decreasing* because *f'* <0 , and *f is concave down* because *f''*<0 , etc.
- Modeling and Optimization (referencing physics, economics, mathematical models, etc)
- Linear Approximation
- Newton's Method
- Differential Equations and Estimation
- Related Rates of Change

Definite Integrals

4 weeks

- Using Calculus to Compute Distance Traveled
- Rectangular Approximation Method
- Riemann Sums
- Converting from Sigma to Integral Notation
- Connections between Definite Integral and Area
- Properties of the Definite Integral
- Average Value of a Function
- Mean Value Theorem for Definite Integrals
- Connections between Differential and Integral Calculus
- Fundamental Theorem of Calculus (Parts I & II)

  Examples of problems similar to AP free response questions are used here. Emphasis is placed on written explanation of units and why the derivative or integral was used in the context of the real-world application. Students are also given functions where analytical integration is not possible and they must use the graphing calculator.
- Estimating Area using the Trapezoidal Rule
- Estimating Area using Simpson's Rule
- Error Analysis

Antiderivatives

2 weeks

- Initial Value Problems
- Properties of Indefinite Integrals
- Slope Fields and Differential Equations
- Integration by Substitution
- Separable Differential Equations

- Integration by Parts (including solving for an unknown integral)
- Tabular Integration
- Applications of Integration (exponential growth/decay, Newton's Law of Cooling, etc)

Applications of Integrals

4 weeks

- Using the Integral to Calculate Net Change
- Area Between Curves
- Integration with respect to x and y Axes
- Volumes of Solids of Revolution (Disk, Washer, and Cylindrical Shell Methods)

Review/Test Preparation

2 weeks

- Multiple-choice practice (Items from past exams—1997, 1998, 2003, and 2008
  Test taking strategies are emphasized
  Individual and group practice are both used

- Free-response practice (Released items from the AP Central website)
  Rubrics are reviewed so students see the need for complete answers
  Individually written responses are crafted. Attention to full explanations is emphasized

Course Assessments

Students are assessed using a variety of methods including *group activities, oral presentations, quizzes and exams.* Students are expected to explain all solutions both verbally and in written form during the course of the year. Proper mathematical notation is also stressed throughout the course and is consistently assessed. All major exams are "mini" AP examinations, in which all problems consist of multiple choice and open-ended AP examination questions that have been released by *College Board* from previous years. (Students are given these examinations approximately once every 3 weeks.) Therefore, the actual AP Calculus Examination that the students take in the spring has been modeled all year in this course.

Technology and Computer Software

Calculators

All students use a TI-83 or TI-84 graphing calculator in the classroom. The teacher uses a TI-84+ model in instruction. We use the calculator as a tool to illustrate ideas and make discoveries about functions in Calculus.
The following technology objectives are required of the students in this course:

- The ability to graph functions in arbitrary viewing windows
- The ability to find the zeros of functions
- The ability to find numerical derivatives of functions
- The ability to calculate the value of a definite integral

.
Students are also required to make connections between the graphs of functions and their analysis, and conclusions about the behavior of functions when using a graphing calculator.

Teacher Resources

Smart board Presentations:

The teacher uses Smart board presentations almost daily to enhance instruction and offer visuals of concepts being studied.

The use of multiple websites are used throughout the course, offering a more pictorial approach to many topics.

In addition, online simulation software is being used to bring the smart board "to life", allowing students to study many concepts in real time. For example, students have the ability to physically drag a tangent along a curve, studying how the derivative changes, in addition to making connections between *f*, *f* ', and *f* '' graphically. When studying volumes, students have the ability to view color animations of volumes being created by revolving a region about an axis, allowing for 3-dimensional viewing of solids. (This is especially effective when teaching the shell method!)

Additional Text Resources:

Ron Larson, Bruce Edwards.
AP edition Calculus, 9^{th} edition. Pearson: Brooks/Cole, 2010.

Jon Rogawski, Ray Cannon.
Calculus – Graphical, Numerical, Algebraic, 3^{rd} edition. Freeman, 2012.

Howard Anton, Irl Bivens, & Stephen Davis.

Calculus – Early Transcendentals, Single Variable, 10^{th} edition. John Wiley & Sons, 2012.

Finney, Ross L., Franklin D. Damana, Bert K. Waits, and Daniel Kennedy.
Calculus – Graphical, Numerical, Algebraic, 3^{rd} edition. Pearson: Prentice Hall, 2007.

Best, George W., J. Richard Lux.
Preparing for the (AB) AP Calculus Examination. Venture Publishing, 1998.

Collegeboard
AP Calculus: Multiple-Choice Question Collection, 1969-1998.

Finney, Ross L., Franklin D. Damana, Bert K. Waits, and Daniel Kennedy.
Calculus – Graphical, Numerical, Algebraic, 3^{rd} edition. Pearson: Prentice Hall, 2007.

Lederman, David, Lin McMullin.
Multiple-Choice & Free-Response Questions in Preparation for the AP Calculus (AB) Examination. D & S Marketing, Inc., 2003.

The College Board
Released Exams: AP Calculus AB and Calculus BC, 1996, 1997, 1998, 2003, 2008.