School Profile

We are a rural school of approximately 1200 students for grades 9-12. Prior to taking AP Calculus, a student must successfully complete Algebra I, Algebra II, Geometry, and Pre-calculus. Most of these students take Algebra I in the 8^{th} grade. The AP Calculus class meets for 100 minutes per day for 36 weeks.

Course outline

The following is an outline of the topics we cover and the usual sequence in which these topics are taught. The time spent is only an estimate of the number of days allotted to each topic because the actual time varies from year to year depending upon the students' abilities. Each student has a TI-83 Plus graphing calculator and is expected to bring it to class each day. Depending upon the ability of the student some years we do an AP summer preparation packet consisting of 4 units that review graphs of basic families of functions, linear equations and rate of change, functions and their graphs, and fitting models to data. Each packet is due at a certain point during the summer. I grade these and we discuss each during the first two days of class. If we do not do the packets I am confident they already know this material.

Student Evaluation

We use calculators to explore concepts daily and all topics are presented using the "rule of four" –graphically, numerically, algebraically, and verbally". Our textbooks incorporate practice problems, writing activities, calculator exploration, and "think about it" questions. All of these are used in daily assignments.

I give and check homework daily and since we do 85% of the problems in each section students can expect one to two hours of homework each night. I give class openers (problems similar to the homework) 3 times a week, we do a set of problems called "getting at the concept" at the end of each section which establishes whether students have truly learned the material by the "rule of four"—graphically, numerically, algebraically, and verbally. I give 2 or 3 quizzes per unit, and a test on each unit in addition to the extra activities listed in parentheses at certain points in some units. Our text also includes an AP calculus examination workbook, which is keyed to the textbook and follows the College Board Topic Outline. I use this for class discussion, calculator exploration, and unit test review. Each of these has ten multiple-choice and one free response question. The course outline below accounts for approximately 30 of the 36 weeks in the course. The remainder of the time is spent in intensive review practicing AP released tests as well as each student working through the entire 2004 AP exam workbook, Preparing for the (AB) AP Calculus Examination, written by George W. Best and J. Richard Lux. These are graded and discussed daily.

Textbook: Larson, Hostetler, & Edwards, *Calculus of a Single Variable,* sixth ed., Houghton Mifflin Co., ISBN: 0-395-88578-7

AP Calculus AB Map

Unit 1 – Limits and Their Properties (3 weeks)

1. A Preview of Calculus
    a. What is calculus?
    b. The tangent line problem
    c. The area problem
2. Finding Limits Graphically and Numerically
    a. An introduction to limits intuitively
    b. Limits that fail to exist
3. Evaluating Limits Analytically
    a. Properties of limits
    b. One-sided limits and two-sided limits
    c. A strategy for finding limits
    d. Dividing out and rationalizing techniques
    e. The Squeeze Theorem
4. Continuity and One-Sided Limits
    a. Continuity at a point and on an open interval
    b. One-sided limits and continuity on a closed interval
    c. Properties of continuity
    d. Intermediate Value Theorem (See student activity 1)
5. Infinite Limits
    a. Infinite limits
    b. Asymptotic behavior of rational and exponential functions

Unit 2 – Differentiation (5 weeks)

1. The Derivative and the Tangent Line Problem
    a. Tangent line to a curve at a point and local linear approximation (See student activity 2)
    b. Derivative of a function
    c. Differentiability and continuity
2. Basic Differentiation Rules and Rates of Change
    a. Constant rule
    b. Power rule
    c. Constant multiple rule
    d. Sum and difference rules

    e. Derivatives of sine and cosine functions
    f. Rates of change- vertical and horizontal motion as well as other applications
3. The Product and Quotient Rules and Higher-Order Derivatives
    a. Product rule
    b. Quotient rule
    c. Derivatives of trigonometric functions
    d. Higher-order derivatives- characteristics of the graph of f, f’, and f”
4. The Chain Rule
    a. The Chain Rule
    b. General power rule
    c. Simplifying derivatives
    d. Trigonometric functions and the Chain Rule
5. Implicit Differentiation
    a. Implicit and explicit functions
    b. Implicit differentiation
6. Related Rates
    a. Finding related rates
    b. Problem solving with related rates
    c. Related rates shoe-box project (See student activity 3)

Unit 3 – Applications of Differentiation (5 weeks)

1. Extrema on an Interval
    a. Extrema of a function
    b. Relative extrema and critical numbers
    c. Finding extrema on a closed interval
2. Rolle’s Theorem and the Mean Value Theorem
    a. Rolle’s Theorem
    b. Mean Value Theorem and its geometric consequences
3. Increasing and Decreasing Functions and the First Derivative Test (graphing packet, see student activity 4)
    a. Increasing and decreasing functions
    b. Monotonicity and concavity
    c. The first derivative test
4. Concavity and the Second Derivative Test
    a. Concavity
    b. Points of Inflection
    c. The second derivative test- again, discuss characteristics of f, f’, and f”
5. Limits at Infinity

    a. Limits at infinity
    b. Horizontal asymptotes
    c. Infinite Limits at Infinity and vertical asymptotes
6. A Summary of Curve Sketching
    a. Analyzing the graph of a function (domain, range, symmetry, intercepts, continuity, asymptotes, differentiability, extrema, concavity, points of inflection, sketching)
7. Optimization Problems
    a. Applied minimum and maximum problems (See student activity 5)
8. Differentials
    a. Linear approximations
    b. Differentials
    c. Error propagation
    d. Calculating differentials

Unit 4 – Integration (5 weeks)

1. Antiderivatives and Indefinite Integration
    a. Antiderivatives
    b. Notation for antiderivatives
    c. Basic integration rules
    d. Initial conditions and particular solutions of differential equations
    e. Slope Fields (see student activity 6)
2. Area
    a. Sigma notation
    b. Area using exhaustion method utilized by Archimedes
    c. Area of a plane region
    d. Upper and lower sums
    e. Midpoint rule
3. Riemann Sums and Definite Integrals
    a. Riemann sums
    b. Definite integrals
    c. Properties of definite integrals
4. The Fundamental Theorem of Calculus
    a. The fundamental theorem of calculus
    b. The mean value theorem for integrals
    c. Average value of a function
    d. The second fundamental theorem of calculus
5. Integration by Substitution
    a. Pattern recognition

    b. Change of variables
    c. General power rule for integration
    d. Change of variables for definite integrals
    e. Integration of even and odd functions
6. Numerical Integration
    a. Trapezoidal rule

Unit 5 – Logarithmic, Exponential, and Other Transcendental Functions (5 weeks)

1. The Natural Logarithmic Function: Differentiation
    a. The natural logarithmic function
    b. The number *e*
    c. Derivative of the natural logarithmic function
2. The Natural Logarithmic Function: Integration
    a. Log rule for integration
    b. Integrals of trigonometric functions
3. Inverse Functions
    a. Inverse functions
    b. Existence of an inverse function
    c. Derivative of an inverse function
4. Exponential Functions: Differentiation and Integration
    a. The natural exponential function
    b. Derivatives of exponential functions
    c. Integrals of exponential functions
5. Bases Other than *e* and Applications
    a. Bases other than *e*
    b. Differentiation and integration
    c. Applications of exponential functions
6. Differential Equations: Growth and Decay
    a. Differential equations
    b. Growth and decay models
    c. Newton's Law of Cooling
7. Differential Equations: Separation of Variables
    a. General and particular solutions
    b. Separation of variables
    c. Applications
8. Inverse Trigonometric Functions: Differentiation
    a. Inverse trigonometric functions
    b. Derivatives of inverse trigonometric functions
    c. Review of basic differentiation rules
9. Inverse Trigonometric Functions: Integration

    a. Integrals involving inverse trigonometric functions
    b. Completing the square
    c. Review of basic integration rules

Unit 6 – Applications of Integration (4 weeks)

1. Area of a Region Between Two Curves
    a. Area of a region between two curves
    b. Area of a region between intersecting curves
    c. Integration as an accumulation process
2. Volume: The Disk Method
    a. The disk method
    b. The washer method
    c. Solids with known cross sections

Unit 7 – Integration Techniques and L'Hopital's Rule (3 weeks)

1. Basic Integration Rules
    a. Fitting integrands to basic rules
2. Trigonometric Integrals
    a. Integrals involving powers of sine and cosine
    b. Integrals involving powers of secant and tangent
    c. Integrals involving sine-cosine products with different angles
3. Indeterminate Forms and L'Hopital's Rule
    a. Indeterminate forms
    b. L'Hopital's Rule

Student Activities

1. Intermediate Value Theorem Writing Activity- each student writes an original real life example of the theorem and explains it in theorem language. They use clip art, etc. to decorate the page, and they are placed on the wall for all to read.

2. We begin the concept of a derivative talking about the function, $y=x^2$, and calculating the slope of the secant line through (1,1) and (2,4). Then I pose the question of how could we find the slope of the tangent line to $y=x^2$ at the point (1,1). We then choose points between x=1 and x=2, getting closer and closer to x=1, and calculate the slope of the secant line between these points. Since students are already very familiar with the concept of a limit, they quickly jump on the fact that we are doing a

limit process. We ultimately use values so close to x=1, that students can surmise the answer which leads us into a derivative by definition.

3. Related Rate Shoebox Project- Each student writes an original related rates problem, provides the solution, and creates a diorama, which contains the problem, in a shoebox to illustrate their problem. After I check each student's problem and their solution, the boxes are set up in a row and students solve all problems, but their own, as a quiz.

4. Graphing Packet- Each student is given a packet of 14 functions: polynomial, rational, radical, and trigonometric. They are to analyze each function with regard to domain, range, symmetry, intercepts, continuity, asymptotes, extrema, points of inflection, concavity, differentiability, and sketch. Of course this does not include exponential and logarithmic functions, but these are addressed with regard to the aforementioned analysis in Chapter 5.

5. Optimization project- optimization is made meaningful by asking students to find the required dimensions for a cylindrical can given its volume of V_0 cubic units. Students then bring in various cans (soup, soda, tuna, etc.). They measure the height and radius of each can. They discover that rarely does a can meet the dimensions they found in the problem they solved. They then write a letter to the company of the product's can they measured (Campbell Soup, Coca Cola, etc.) and send their computations and ask why the company does not use a can with their dimensions. The student usually receives an answer in a few weeks, along with some coupons. The companies' answers give insight into manufacturing costs and techniques.

6. Slope Field Activity- I have a 3'x 3' graph board that sits in the white board tray. I give each student several ordered pairs that fit on the graph. For a given differential equation, each student calculates the slopes at his/her coordinate position, goes to the board, and draws a short line segment with their calculated slope using their ordered pair as the midpoint of the segment. They continue this process until the class completes the slope field.