AP Calculus AB Syllabus

Introduction
Calculus is a powerful and important part of the study of Mathematics. Differential and Integral Calculus are the 2 main branches of Calculus. Differential Calculus deals with changing quantities, while Integral Calculus deals mainly with finding sums of infinitesimally small quantities. It is the goal of this course for all students to develop an appreciation of Calculus and to pass the AP Calculus AB exam in the spring. To that end we will cover all the topics that are listed on the “AP Calculus course description” as well as a brief look at historical development of Calculus.

Teaching Strategies
It is stressed throughout this course that students should be able to work with functions, limits, derivatives and integrals represented graphically, numerically, analytically, or verbally, and should understand the connections among these representations. Therefore it has been a major part of this course to incorporate the use of graphing calculators. Each student who does not have a graphing calculator may check out a TI-83 from the school library. Small group Explorations with the graphing calculators allow students to develop and verbalize various concepts before they are analyzed through algebraic techniques. Students are encouraged to talk with each other and seek out any additional help as needed.

Calculators and Technology
The capabilities and limitations of calculators are utilized and illustrated with the aid of TI-Smart View (Emulator Software for the TI84 plus Family) This software allows the “SmartBoard” to become an oversized TI graphing Calculator so that students may see the keystrokes as they are entered, as well as see exactly what is displayed on the calculator screen. This facilitates the teaching and learning of not only Calculus but also the correct use and application of calculators. In addition to TI-Smart View, the Geometer’s Sketchpad is used in class to aid in viewing graphs as well as illustrate/animate volumes of revolution, area of between curves, and other Calculus topics.

Activities
The year begins with a review of Pre-Calculus which includes an extensive review of when and how to use a graphing calculator. This review covers topics such as, how to find roots, the intersection of functions, sketching graphs in an appropriate window and why or how the calculator may fail to give correct information.
There are several Explorations throughout this course which provide students with the perfect opportunity to become an active learner and discover the mathematics on their own and then to communicate their understanding in groups or writing. Honing these critical thinking and problem-solving skills will ultimately benefit them in all of their pursuits including their AP Exams. These discoveries are then reinforced through discussions and teacher led activities. For example in the Exploration Zooming to “see” Differentiability students are given two different functions and asked if either of the functions is differentiable at x = 0? By using the zoom feature on the calculator students soon discover the concept of local linearity. Group and class discussion quickly leads to the topic of when the derivative might fail.
Other activities include “A 20 Minute Car Ride” where students record the cumulative distance traveled at 1 minute intervals for a period of 20 minutes. The data are then graphed. By looking at the graph students then determine over what time intervals the car has the greatest speed, when the car was increasing an decreasing its speed. Students then calculate the average speed over several different time intervals. They are then asked to find the instantaneous speed. The topic of continuity and derivatives are also discussed in relation to their graph and data. A similar activity called “Another 20 Minute Car Ride”, students record the cars speed instead of distance traveled. The data are then graphed and students calculate distance traveled using various Riemann sums. Students also find average velocity, intervals of increasing and decreasing velocity, and intervals of decreasing acceleration.
Towards the end of the year students will complete the “Volumes of a solid with known cross section”, a project which entails making a three-dimensional model of a volume created using a student-generated function and a known cross section. Students layer several cross sections with a width of approximately ¼ inch together to create their solid. They then calculate the volume of their model two different ways, first by utilizing Riemann sums with an excel spread sheet and second by calculating the volume with definite integrals and a calculator. The project is then presented to the class with explanations of their methods and results.
Student Evaluations

6 Week progress grades are computed using homework, class participation, explorations, tests, quizzes and projects. Test and quizzes are similar to the AP exams in that they contain multiple choice and free response questions as well as sections in which they may be allowed to use calculators. Semester grades also include finals which are similar to the actual AP Exams.

AP Calculus AB Course Outline

Unit 1: Pre-Calculus Review (2–3 weeks)

A. Lines
   1. Slope as rate of change
   2. Parallel and perpendicular lines
   3. Equations of lines

B. Functions and graphs
   1. Functions
   2. Domain and range
   3. Viewing and Interpreting Graphs
   4. Even and Odd functions-Symmetry
   5. Families of function
   6. Piecewise functions
   7. Composition of functions
     Calculator Exploration 1.2.1 Composing Functions

C. Exponential and logarithmic functions
   1. Exponential growth and decay
   2. The Number e

D. Functions & Logarithms
   1. One to One and Inverse functions
     Calculator Exploration 1.5.1 Testing for inverses graphically
   2. Logarithmic functions
   3. Properties of logarithms

E. Trigonometric functions
   1. Radian Measure
   2. Graphs of basic trigonometric functions
      a. Domain and range
      b. Transformations
      c. Inverse trigonometric functions
   3. Periodicity
   4. Even and Odd Trig Functions
   5. Applications and Models

Unit 2: Limits and Continuity (3 weeks)

A. Rates of change
   1. Average and Instantaneous
   2. Definition and Properties of Limits
   3. One and Two-sided limits

B. Limits involving infinity
   1. Asymptotic behavior
   2. Properties of limits
   3. End behavior
   4. “Seeing” limits

D. Continuity
   1. Continuity at a point
   2. Discontinuous functions
      a. Removable discontinuity
      b. Jump discontinuity
      c. Infinite discontinuity
     Calculator Exploration 2.3.1 Removing a Discontinuity
   3. Continuous functions
   4. Intermediate Value Theorem for Continuous Functions

E. Rates of change
   1. Average rate of change
   2. Secant and Tangent to a curve
   3. Slope of a curve
   4. Normal to a curve

Unit 3: The Derivative (5 weeks)

A. Derivative of a Function
   1. Definition of the derivative
   2. Relationships between graph of f and f’
   3. One sided derivatives

B. Differentiability
   1. How f(a) Might fail to exist
   2. Local linearity
     Calculator Exploration 3.2.1 Zooming in to “see” Differentiability
   3. Numeric derivatives using the calculator
   4. Differentiability and continuity

C. Rules for Differentiation
   1. Product and Quotient Rules
   2. Power rules
   3. Second and Higher Order Derivatives

D. Velocity and Other rates of Change
   1. Instantaneous rates of Change
   2. Motion along a line
   3. Sensitivity to change
   4. Derivatives in Economics

E. Derivatives of trigonometric functions
   1. Derivatives of Sine and Cosine
   2. Simple Harmonic Motion
   3. Derivatives of Other Basic Trig Functions

F. The chain rule
   1. Derivative of a composite function
   2. Repeated use of the Chain Rule

G. Implicit derivatives
   1. Implicitly Defined Functions
   2. Implicit Differentiation Process
     Calculator Exploration 3.7.1 An Unexpected Derivative

H. Derivatives of inverse trigonometric functions
   1. Derivatives of Inverse Functions
     Calculator Exploration 3.8.1 Finding a Derivative on an Inverse Graph Geometrically
   2. Derivatives of inverse trigonometric functions

I. Derivatives of exponential and logarithmic functions
   1. Derivative of e^x
   2. Derivative of a^x
   3. Derivative of ln x
   4. Derivative of log ax

Unit 4: Applications of the Derivative (4 weeks)

A. Extreme value of Functions
   1. Global (absolute) extrema
   2. Local (relative) extrema

B. Mean Value Theorem
   1. Mean value theorem
   2. Increasing and decreasing functions

C. Connecting f’ & f” with the Graph of f
   1. First derivative test for extrema
   2. Concavity and points of inflection
   3. Second derivative test for extrema
     Exploration 4.3.2 Finding f from f’ and f’’
D. Modeling and Optimization
   1. Examples from business & Industry
   2. Examples from Mathematics
   3. Strategy for Solving Max-min Problems
   4. Examples from Economics

E. Linearization and Newton's Method
   1. Linear Approximation
      Calculator Exploration 4.5.1
      Approximating with Tangent Lines
   2. Newton's Method
      Calculator Exploration 4.5.2
      Using Newton's Method on the calculator
   3. Differentials
   4. Estimating change with differentials

F. Related Rates
   1. Related rate equations
   2. Related rate problem strategy

Unit 5: The Definite Integral (3 weeks)
A. Estimating with Areas
   1. Distance Traveled
   2. Riemann sums, RRAM, LRAM, MRAM
   3. Volume of a sphere
   4. Definite Integrals

B. The Fundamental Theorem of Calculus (FTC) (Part 1)
   1. FTC by Graphical, Numerical, and Analytical methods
   2. Activity 20 minute ride.
      Calculator Exploration 5.4.1
      Graphing integrals
      Calculator Exploration 5.4.2
      Changing “a” in the FTC

C. Definite integrals and antiderivatives
   1. The Average Value Theorem
      Exploration 5.3.2
      Finding the Derivative of an integral

D. The Fundamental Theorem of Calculus (Part 2)
   1. How to find total area analytically
   2. How to find total area numerically
   3. Applications

E. Trapezoid Rule-Error Analysis

Unit 6: Differential Equations and Mathematical Modeling (3-4 weeks)
A. Antiderivatives
   1. Solving Initial Value problems
   2. Antiderivatives and indefinite integrals
   3. Properties of integrals
   4. Applications

B. Integration using u-substitution
   1. Power rule
   2. Trigonometric integrands
   3. Separable differential Equations

C. Exponential Growth and Decay
   1. Law of Exponential Change
   2. Newton’s Law of cooling
      Calculator Exploration 6.4.1
      Slowing Down More Slowly

Unit 7: Applications of Definite Integrals (3 weeks)
A. Integral as Net Change
   1. Linear Motion Revisited
   2. Strategy for Modeling with Integrals
   3. Consumption over Time

B. Areas in the Plane
   1. Areas between Curves
   2. Area Enclosed by Intersecting Curves
      Calculator Exploration 7.2.1
      Using Newton's Method on the calculator
   3. Boundaries with Changing Functions
   4. Integrating with Respect to y

C. Volumes
   1. Volume as an Integral
   2. Volume of known Cross Sections
   3. Volume by Washers
   4. Volume by Cylindrical Shells
      Calculator Exploration 7.3.1
      Volume by Cylindrical Shells
      Cross Section Area Project

Unit 8: History of Calculus
A. Isaac Newton and Gottfried Leibniz

The timing on this schedule is approximate and leaves several weeks for flexibility with teaching and learning time management.

Teacher resources
Major Text
Finney, Ross L., Franklin D. Demana, Bert K. Waits, and Daniel Kennedy.

Technology Resources
Graphing calculators are required. The teacher uses the TI-83 in class. Students who do not have a graphing calculator may acquire a TI-83 from the library.

TI-Smart View (Emulator Software for the TI84 plus Family) from Texas Instruments

"Calculus in Motion" (A series of Geometer's sketchpad presentations by Audrey Weeks, http://www.calculusinmotion.com)