

# AP Calculus AB

## Course Overview

The main objective in teaching AP Calculus AB is to provide the students with a strong mathematical foundation and tools that will enable them to be successful in future courses. We explain to the students that AP Calculus AB will cover four main ideas; limits, derivatives, indefinite integrals, and definite integrals. In addition to learning the mechanics of each topic, students will be asked to use these skills in real world applications. Instruction of the class includes lecture, group work, student discovery, and use of technology (TI-83 plus is available to every student). Students understand the challenge presented to them in the AP Calculus AB course. Students are required to be dedicated to the successful completion of the AP Calculus AB program. Teacher and students work together to achieve this goal.

## Course Objectives

1. To foster an understanding of the nature of mathematical thought, develop critical thinking and communication skills.
2. To investigate the limit concept and relate it to the concepts of the derivative and the definite integral.
3. To use the calculus to study the properties of the functions, their graphs, their rates of change, and their use in modeling and applications.
4. To examine the concept, means of constructions and the applications of the infinite summation process, and to relate it to the definite integral.
5. To strengthen intuition and deepen the insight of mathematical principles by observing and relating graphical, algebraic and numeric properties of mathematical objects and processes.
6. To increase student awareness of the multitude of ways of solving a problem, and to encourage the student to evaluate the strengths and weakness of various problem solving strategies.
7. To strengthen the student's skills in algebraic manipulation, the ability to interpret graphs, and the command of mathematical notation.

# Course Planner

Below is the sequence of our AP Calculus AB program.

Note: The time frames are just estimates and will vary depending on each class.

## A Library of Functions (Chapter P)

Time: Approximately 2 weeks

1. Graph functions and identify by family
2. Determine domain, range, intercepts and symmetry (including odd and even)
3. Calculate rate of change of linear functions
4. Evaluate functions, combined functions, and composition of functions

## Limits and Their Properties (Chapter 1)

Time: Approximately 3 weeks

- 1.2 - Finding Limits Graphically and Numerically
- 1.3 – Evaluating Limits Analytically
- 1.4 – Continuity and One-Sided Limits
- 1.5 – Infinite Limits

Sample Activity:

On the first day of limits the students investigate the value of limits using the TI-84 plus. The students are provided with a list of different functions and have to evaluate the limit at specific values. The students then put the functions into their calculator and use the table feature to evaluate the limit. The students have to use various change in table values, starting at 1 and decreasing by a power of 10 until they get to .00001. Functions where a limit does not exist are included in the list of original functions. Students are required to explain the behavior of the function as it approaches the limit value in these cases.

## Differentiation (Chapter 2)

Time: Approximately 3 weeks

- 2.1 – The Derivative and the Tangent Line Problem
- 2.2 – Basic Differentiation Rules and Rates of Change
- 2.3 – The Product Rule and Quotient Rules and Higher-Order Derivatives
- 2.4 – The Chain Rule
- 2.5 – Implicit Differentiation
- 2.6 – Related Rates

Sample Activity:

Students will use their laptops to access a calculus applet. The applet provides a random function and two points on the graph. The applet also indicates the position of each point in a table.

The students will calculate the slope of the secant line using the values in the table. Students will then drag the second point closer to the first point, and again calculate the slope of the new secant line. The students will continue this process until the second point and the first point are located in the same position. The students will be required calculate the slope of at least 4 different secant lines.

After calculating the slope of the secant line leading to tangent line the students will compare their results and try to formulate the definition of the derivative. As a class we will come up with a final definition.

## **Applications of Differentiation (Chapter 3)**

Time: Approximately 4 weeks

- 3.1 – Extrema on an Interval
- 3.2 – Rolle's Theorem and the Mean Value Theorem
- 3.3 – Increasing and Decreasing Functions and the First Derivative Test
- 3.4 – Concavity and the Second Derivative Test
- 3.5 – Limits at Infinity
- 3.6 – A Summary of Curve Sketching
- 3.7 – Optimization Problems
- 3.9 – Differentials

Sample Activity:

Student will be given a large index card with a function graphed on the card. There will be no markings on the graph other than the scale of the graph. Students will be informed that each card either has a graph of the function or graph of the derivative of a given function.

Students will then have to circulate around the room and find their match. The students will also have determine if the card they are holding is the function or the derivative of the function.

Students will have to use key features such as extreme values, increasing / decreasing intervals, and the overall shape of the curve to help determine their match.

## **Integration (Chapter 4)**

Time: Approximately 3 weeks

- 4.1 – Antiderivatives and Indefinite Integral
- 4.2 – Area
- 4.3 – Riemann Sums and Definite Integrals
- 4.4 – The Fundamental Theorem of Calculus (First and Second Fundamental Theorem)
- 4.5 – Integration by Substitution
- 4.6 – Numerical Integration (Trapezoid Rule)

Sample Activity:

During study of the Riemann's sum the students use the TI-83 plus to calculate areas under the curve using right-hand and left-hand rectangles. In this activity, students will calculate and analyze Riemann sums. They will draw rectangles whose areas correspond to terms of Riemann sums and observe the convergence of left-hand and right-hand Riemann sums by using graphing handhelds to automate the production of Riemann sums with regular partitions having a large number of subintervals. This allows the students to calculate Riemann's sums using a large numbers of rectangles. We do this activity for several different functions. This lab can be found at the TI website [http://education.ti.com/educationportal/activityexchange/activity\\_detail.do?cid=us&activityid=4371](http://education.ti.com/educationportal/activityexchange/activity_detail.do?cid=us&activityid=4371).

## **Logarithmic, Exponential, and Other Transcendental Functions (Chapter 5)**

Time: Approximately 5 weeks

- 5.1 – The Natural Logarithmic Function and Differentiation
- 5.2 – The Natural Logarithmic Function and Integration
- 5.3 – Inverse Functions
- 5.4 – Exponential Functions: Differentiation and Integration
- 5.5 – Bases Other than  $e$  and Applications
- 5.6 – Differential Equations: Growth and Decay
- 5.7 – Differential Equations: Separation of Variables

Sample Activity:

We are going to do an online activity using the website Desmos. The purpose of the activity is to help students review exponential models beginning on the Calculus around these models. Using a graphing calculator to solve problems will allow the class to spend time focusing on interpreting the results and using precise notation, both of which are heavily emphasized on the AP Calculus Exam.

Example of the activity:

Ibuprofen has a half-life of approximately 3 hours in the human body. A common dose of ibuprofen for adults is 400 milligrams. Create a data table to represent the situation starting with an adult taking a 400 milligram dose at 8:00 am.

- a) Find a formula for the amount of ibuprofen remaining after  $t$  hours.
- b) Find the amount remaining after 1 day.
- c) When is the amount reduced to 40 mg?

We will proceed to do the same thing with other examples such as: As a cup of tea cools, the temperature of the tea is modeled by a function  $C$  for time greater than or equal to zero, where  $t$  is time measured in minutes and temperature  $C(t)$  is measured in degrees Celsius. Values of  $C(t)$  at selected values of time will be shown in a table. The students will have to come up with a model and use it to predict temperature at different times. We can also bring in Newton's Law of Cooling to see how math is used in the sciences.

## **Applications of Integration (Chapter 6)**

Time: Approximately 4 weeks

- 6.1 – Area of a Region Between Two Curves
- 6.2 – Volume: Disc Method, Washer Method, and Known Cross Section
- 6.3 – Volume: Shell Method

Sample Activities

To help visualize volumes with a known cross section students will construct a model of different solids using Play Doh. Each group will be given a form they will use to create their different solids (pyramids, half spheres, rectangles, cubes, etc.)

Once the solids have been formed using Play Doh, the students will place the form on a set of axes with an outline of where the solid should be placed. Students will then take a plastic knife and cut the solid into several cross sections. They will calculate the volume of each cross section to come up with the volume of the solid. This should be a good visualization of how to calculate volumes of a known cross section.

## **Integration Techniques, L'Hopital's Rule, and Improper Integrals (Chapter 7)**

Time: Approximately 1 week

7.7 – Indeterminate Forms and L'Hopital's Rule

## **After the AP Exam**

### **Applications of Integration (Chapter 6)**

Time: Approximately 2 weeks

1. Determining arc length and surfaces of revolution.
2. Applications of integrations involving work problems.

## **Integration Techniques, L'Hopital's Rule, and Improper Integrals (Chapter 7)**

Time Approximately: 2 weeks

1. Integration by parts.
2. Integrate trigonometric functions, also using substitution.
3. Integrate using partial fractions.

## **Teaching and Evaluating the Course**

Instruction of the class includes lecture, group work, student discovery, and use of technology (TI-84 plus is available to every student). The class meets every school day for 42 minutes.

The above objectives of student learning will be assessed as follows:

1. Weekly homework sets.
  - a. Problems from the text.
  - b. Sample AP questions, both multiple choice and free response.
2. Weekly quizzes.
3. Two cumulative exams per marking period (8 for the whole year).
4. Projects completed throughout the year (projects count as a test grade).

The grade breakdown is as follows:

Tests 40%  
Quizzes 35%  
Homework 15%  
Class Participation 10%

## **Primary Text Book**

Larson, Hostetler, and Edwards. Calculus, 6<sup>th</sup> ed. Boston, Massachusetts: Houghton Mifflin Company, 1998.