AP® Calculus AB Syllabus

Course Overview

The focus of this course is to help students understand and apply the three big ideas of AB Calculus: limits, derivatives, and integrals and the Fundamental Theorem of Calculus. Imbedded throughout the big ideas are the mathematical practices for AP® Calculus: reasoning with definitions and theorems, connecting concepts, implementing algebraic/computational processes, connecting multiple representations, building notational fluency, and communicating mathematics orally and in well-written sentences.

Course Philosophy

- Mathematics is the language of science. This course is designed to teach new mathematical skills, reinforce old skills, and expand the ability to integrate multiple concepts throughout the problem solving process. Students are expected to use correct mathematical notation throughout the course.
- Memories fade, so this course will focus on the understanding of mathematics. Students will engage in graphical, numerical, analytical, and verbal representations as well as demonstrate the connections among them. Much of this will be accomplished through discovery and practice.
- Math is not a spectator sport, you must *do* math to *fully understand* math. Students will work in groups at the boards on a daily basis. Students will present their solutions orally to the class and be asked to find errors in the reasoning of others when appropriate.

Course Materials

Primary Text: Finney, Ross L. et al. *Calculus: Graphical, Numerical, Algebraic*, 5th ed. Boston, Pearson, 2016.

Graphing Calculator: A classroom set of TI-nspire CX CAS calculators will be available for daily use. Students may also rent a TI-84 calculator from the school. Students will be taught how to use both these tools to deepen their understanding of concepts throughout the course.

Portfolio: Students are required to maintain an organized portfolio of their work. At a minimum it will contain class notes, daily board problems, quizzes, projects, and tests.

Pencil and Eraser: Problems in this course will be challenging, so errors and mistake are expected. These inevitable mistakes are easier to correct if they are in pencil.

Auxiliary Materials: Released exams, study guides, old textbooks and other materials available on the internet will be used throughout the year to prepare students for free response and multiple choice style questions.

Course Outline times are approximate and vary based on student mastery – remaining time is used to review and practice for the AP® exam.

Prerequisites for Calculus – Chapter 1 (1 week)
Students complete a review of precalculus materials over the summer. Additional reviews will be integrated into future lessons as needed.

- 1.1 Linear Functions
- 1.2 Functions and Graphs
- 1.3 Exponential Functions
- 1.5 Inverse Functions and Logarithms
- 1.6 Trigonometric Functions.

Big Idea 1: Limits
Limits and Continuity – Chapter 2 (4 weeks)

- 2.1 Rates of Change: average and instantaneous, definition and properties of limits
- 2.2 Limits Involving Infinity
- 2.3 Continuity: continuity at a point and continuous functions, Intermediate Value Th^{m}
- 2.4 Rates of Change and Tangent Lines
- 9.2 L'Hopital's Rule: Indeterminate Forms $0/0$ and ∞/∞. (covered after derivatives)

Sample Activity: Students explore limits at discontinuities using tables in their calculators, by graphing functions and selecting appropriate viewing windows, and using algebraic techniques to simplify expressions. Through carefully selected problems students discover and then write the principle of dominance.

Sample Activity: Students are provided with a set of functions presented both analytically and graphically. They must use the definition of continuity to prove the functions are either continuous or discontinuous. If discontinuous, they must classify the type of discontinuity. Students orally present their reasoning and conclusions to their classmates.

Note: Students are introduced to delta-epsilon proofs of limits and asked to graphically demonstrate an understanding, but are not required to complete delta-epsilon proofs.

Big Idea 2: Derivatives
Derivatives – Chapter 3 (4 weeks)

- 3.1 Derivatives of a Function: Definition of the derivative of *f* vs. the derivative of *f* at a point. Estimating derivatives using data.
- 3.2 Differentiability: connecting differentiability and continuity, Intermediate Value Th^{m}

3.3 Rules for Differentiation
3.4 Velocity and Other Rates of Change
3.5 Derivatives of Trigonometric Functions

Sample Activity: Students use calculators to graph several secant lines which get closer and closer to approximating a tangent line. They then learn how to find the slope of a tangent line analytically using a limit process and using their calculator.

Sample Activity: Students use the definition of a derivative to find the derivative of several functions. Looking for patterns in these derivatives, they propose rules for constant functions, lines, and lower order polynomial functions.

Sample Activity: Students graph the sine and cosine functions. Using these graphs they estimate the slope of several tangent lines. These slope values are plotted directly below the original function and students guess the derivate of the sine and cosine function.

More Derivatives – Chapter 4 (3 weeks)

4.1 Chain Rule
4.2 Implicit Differentiation
4.3 Derivatives of Inverse Trigonometric Functions
4.4 Derivatives of Exponential and Logarithmic Functions

Applications of Derivatives – Chapter 5 (4 weeks)

5.1 Extreme Values of Functions: critical values, absolute (global) vs. relative (local)
5.2 Mean Value Theorem for Derivatives and Rolle's Theorem
5.3 Connecting *f'*, and *f''* with the Graph of *f*
5.4 Modeling and Optimization
5.5 Linearization and Differentials
5.6 Related Rates

Sample Activity: Students are provided with several cards from five categories (written description of a function, a function expression, the graph of a function, the graph of the first derivative, and the graph of the second derivative). They work in teams to match each set of cards.

Sample Activity: Students are asked to find a linear approximation to a function at a point, graphically display the function and the approximation, then discuss whether the approximation over or under estimates the actual function value using both graphical and analytical reasoning.

Sample Activity: Students are provided with several functions on a closed interval. For each function and interval they must determine if the Mean Value Theorem is applicable. If so, they must find all numbers that satisfy the Mean Value Theorem. Students orally present their reasoning and conclusion to the rest of the class.

Note: As students discuss how f' and f" are used to graph f, they are also asked to relate back to limits and continuity.

Big Idea 3: Integrals and the Fundamental Theorem of Calculus
The Definite Integral – Chapter 6 (6 weeks)

- 6.1 Estimating with Finite Sums
- 6.2 Definite Integrals: Riemann Sums and definite integrals on a calculator
- 6.3 Definite Integrals and Antiderivatives: Mean Value Theorem for definite integrals
- 6.4 Fundamental Theorem of Calculus: Antiderivative Part and Evaluation Part
- 6.5 Trapezoidal Rule

Sample Activity: Students calculate the left and right Riemann Sum approximations to definite integrals and compare these results to the value found by computing the definite integral on a graphing calculator. They must use calculus terms to explain whether a specific Riemann Sum over or under estimates the actual value.

Student Activity: Students work at the board in groups and are required to find the value of a definite integral using the limit definition. They must show all work using proper notation (define variables, definite integral notation, limit notation, and summation notation) for each step. Students are then asked to identify both mathematical and notational errors in each other's work.

Student Activity: Students will be required to perform symbolic integration on the TI-nspire and by hand, then use algebraic simplification to show the answers are equivalent.

Differential Equations and Mathematical Modeling – Chapter 7 (4 weeks)

- 7.1 Slope Fields
- 7.2 Antidifferentiation by Substitution
- 7.4 Exponential Growth and Decay: Solve using separation of variables

Sample Activity: Students work in groups to match differential equations with both their slope field and written description of the solution curve. They then use a graphing calculator to confirm their results.

Sample Activity: Students work in teams using Newton's Law of Cooling to solve a crime scene investigation to determine which of five suspects murdered their calculus teacher. Their final report must be written in complete sentences explaining their step by step mathematical reasoning as well as use correct mathematical notation throughout.

Applications of Definite Integrals – Chapter 8 (3 weeks)

- 8.1 Accumulation and Net Change: Linear motion and distance traveled
- 8.2 Areas in the Plane: Under a curve and between two curves
- 8.3 Volumes: Known cross sections, disk method, washer method and shell method
- 8.5 Applications from Science and Statistics

Sample Activity: Students will review released student responses to AP® Calculus AB free response questions involving area and volume that did not receive full credit. They must find the students' mistake(s) and explain the correct process to solve the problem.

Evaluation notes:

- Multiple evaluations will require a response in written sentences. For example "In your own words, explain how derivatives can be used to find and classify extrema."
- Students must show all work for full credit. For problems solved using a calculator, only the setup is required.
- Three notation errors or more will result in a reduced grade.