

# Course Syllabus

## AP CalculusBC

### *I. Course Description*

This course covers the topics of limits, differentiation, integration, and their applications as well as sequences and series. The course will be taught on the college level, preparing students to take the AP Calculus BC exam in May. Students who meet or exceed a satisfactory grade could be exempt from a college Calculus I and Calculus II course. Calculus AB is a prerequisite for this course.

### *II. Materials & Equipment*

Textbook: Calculus: Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy  
A TI-89 graphing calculator is required.

### *III. Course Goals & Objectives*

Enduring Understanding: Students will understand (that)

- The meaning of the derivative in terms of rate of change and local linear approximations
- Functions can be represented graphically, numerically, analytically or verbally and understand the connections among these representations.
- The meaning of the definite integral both as a limit of Riemann sums and as a net accumulation of a rate of change.
- Modeling real-world problem situations can be done using functions, differential equations, or integrals
- Differential equations can be represented with a slope field. Additionally, they should be able to solve separable differential equations analytically.
- Exploring Series intuitively and developing methods from determining which series converge and diverge.

### *IV. Course Topics (Summary Outline)*

#### **I. Limits and Continuity**

- Rates of Change and Limits
- Limits Involving Infinity

\*This section covers asymptotic and unbounded graphical behavior and students are required to describe such behavior in terms of limits involving infinity. By studying end behavior models, students will compare relative magnitudes of functions and their rates of change.

- Continuity

\*This section begins with an intuitive understanding of continuity, then covers continuity in terms of limits and briefly covers the geometric Theorem that apply to continuous functions.

- Rates of Change and Tangent Lines

\*This chapter begins with an intuitive understanding of the limiting process, then covers calculating limits using algebra and estimating limits from graphs or tables of data.

#### **II. Derivatives**

- Derivative of a Function
- Differentiability
- Rules for Differentiation
- Velocity and other Rates of Change
- Derivatives of Trigonometric Functions
- Chain Rule

- Implicit Differentiation
- Derivatives of Inverse Trigonometric Functions
- Derivatives of Exponential and Logarithmic Functions

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these representations.

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

\*In this unit, the concept of derivative is studied from many perspectives with emphasis on the connection between the ideas. Perspectives include: derivative graphically, numerically and analytically; interpreted as an instantaneous rate of change; defined as the limit of the difference quotient; compare and contrast continuity and differentiability; as the slope at a point; instantaneous rate of change as the limit of average rate of change; calculations are done both explicitly and implicitly using basic rules for sums, products, quotients and chain rule, of a variety of types of functions including polynomial, exponential, logarithmic, trigonometric and inverse trigonometric functions; applications involving position, velocity, acceleration and speed.

### III. Applications of Derivatives

- Extreme Values of Functions

\* In this section, students must communicate mathematics and explain solutions to problems both verbally and in written sentences.

- Mean Value Theorem
- Graphs of  $f$ ,  $f'$ , and  $f''$

\*The section includes analysis of graphs emphasizing the interplay between the geometric and analytic information and on the use of calculus both to predict and to explain the observed local and global behavior of a function.

- Modeling and Optimization

\* In this section, students must communicate mathematics and explain solutions to problems both verbally and in written sentences.

- Linearization

\*In this section, derivatives are used to write the equations of tangent lines and study local linear approximations. Newton's Method for approximating function values is also covered.

- Related Rates

\*In this section, verbal descriptions of equations involving derivatives are translated into equations involving derivatives and vice versa.

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

\*In this unit, derivatives are used to analyze properties of graphs and corresponding characteristics of graphs of  $f$ ,  $f'$  and  $f''$ , such as where the functions are increasing/decreasing or concave up/down, extrema and points of inflection.

### IV. The Definite Integral

- Estimating with Finite Sums

- Definite Integrals
- Antiderivatives
- Fundamental Theorem of Calculus
- Trapezoidal Rule

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

\*In this unit, students study: definite integrals as the limit of Riemann sums; both parts of the Fundamental Theorem of Calculus; interpretation of integrals as area under a curve; calculation of numerical approximations of definite integrals using rectangles, trapezoids and Simpson's rule.

### V. Differential Equations and Mathematical Modeling

- Antiderivatives and Slope Fields

\*In this section, the graphical interpretation of differential equations as a slope field is covered.

- Integration by Substitution

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

\*In this unit, students learn to evaluate integrals and find antiderivatives by reversing basic derivative rules as well as by substitution of variables. In addition, students find specific antiderivatives using initial conditions, and solve separable differential equations.

- Integration by Parts
- Exponential and Logistic Growth Models
- Numerical Approximation Methods

### VI. Applications of Definite Integrals

- Integral as Net Change
- Areas in the Plane

\* In this section, students must communicate mathematics and explain solutions to problems both verbally and in written sentences.

- Volumes

\* In this section, students must communicate mathematics and explain solutions to problems both verbally and in written sentences.

- Lengths of Curves
- L'Hopital's Rule

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

\*In this unit, students apply the integral concept in a variety of situations including: accumulated change; area of a region; volume of a solid; distance traveled by a particle.

### VII. L'Hopital's Rule, Improper Integrals, and Partial Fractions

- L'Hopital's Rule
- Relative Rates of Growth
- Improper Integrals
- Partial Fractions and Integral Tables

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

### **VIII. Infinite Series**

- Power Series
- Taylor Series
- Convergence

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

### **IX. Parametric, Vector and Polar Functions**

- Parametric Functions
- Vectors
- Polar Coordinates, Graphs and Curves

\*In this unit, students will work with functions represented in a variety of ways -- graphically, numerically, analytically, and verbally -- and emphasizes the connections among these

\*In this unit students are required to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

## Teaching Strategies

1. Each topic is presented numerically, geometrically, symbolically, and verbally as students learn to communicate the connections among these representations.
2. Justifications of responses and solutions are part of the routine when solving problems. Students are encouraged to express their ideas in carefully written sentences that validate their process and conclusions.
3. Students make extensive use of the TI-89 calculator. Each student has his or her own calculator.
4. Students use their calculators to:
  - (a) Perform numerical integration
  - (b) Find points of inflection
  - (c) Show Riemann sums
  - (d) Compute partial sums
  - (e) Use Euler's method
  - (f) Show a slope field
  - (g) Draw a solution curve on a slope field
  - (h) To sketch implicitly defined functions
5. Sections I through IV are considered review from Calculus AB. These sections are covered as needed throughout the first month of the course. The majority of the course is devoted to studying techniques of integration and series.
6. Students regularly complete practice multiple-choice questions from AP Exam Prep material.
7. Each week students must complete one AP Calculus AB free-response question.
8. All tests are two periods in length, one with calculator usage and one without.
9. Students are encouraged to work cooperatively on in-class worksheets and practice AP problems.
10. Circular functions, exponential functions, and logarithmic functions are used throughout the course. Students have previously studied these functions, so we deal with the derivatives of these functions early in the course.