Calculus AB
Advanced Placement

Pre-Requisites:
All AP Calculus AB students will have completed the required secondary mathematics designed for college-bound students: prerequisite courses in which they study algebra, geometry; trigonometry, analytic geometry, and elementary functions. An extended initial effort ensures all enrolled students are familiar with the properties of functions, the algebra of functions, the graphs of functions, the language of functions (domain and range, odd and even, periodic, symmetry, zeros, intercepts, and so on) and know the values of the trigonometric functions of the numbers $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}$, and their multiples.

Introduction:
By studying calculus, students can use previous mathematic knowledge and study it on a more dynamic level. The use of the limit process allows students to explore concepts that deal with motion and the results of motion. AP Calculus AB is primarily concerned with developing concepts and providing experience in theory, fundamentals and applications. Concepts will be explored graphically, numerically, analytically and verbally. The major components of this course focus on limits, derivatives, indefinite integrals and definite integrals.

Technology: (R2) (C5) (C3)
Students will be supplied with a TI- 84 Graphing Calculator. They will be taught how to use the graphing calculator as a tool for finding solutions to problems. Specifically, they must be able to…

1) plot the graph of a function within an arbitrary viewing window,
2) find the zeros of functions (solve equations numerically),
3) numerically calculate the derivative of a function, and
4) numerically calculate the value of a definite integral.

Students are encouraged to use graphing calculators to explore concepts and to verify results. However, students will be shown that the technology does have limitations. Therefore, students will be expected to be able to support their solutions mathematically.

R2
The school ensures that each student has a graphing calculator for individual use inside and outside of the classroom, with all of the capabilities listed in the AP Calculus Course Description.

C5
The course teaches how to use graphing calculators to help solve problems, experiment, interpret results, and support conclusions.

C3
The course provides students with the opportunity to work with functions represented in a variety of ways – graphically, numerically, analytically, and verbally – and emphasizes the connections among these representations.

C4
The course teaches students how to communicate mathematics and explain solutions to problems both verbally and in written sentences

Assignments and Assessments: (C3) (C4)

Class assignments and activities will be done so that students must explain problems written and orally. Students will be asked to approach problems in a variety of ways, including analytically, graphically, numerically, and orally. Classwork/homework assignments will be given to reinforce and expand on the concepts worked on in class. Solution manuals will be provided to students, therefore students are able to self-asses their progress during a unit of study. Projects will be assigned to help deepen understanding of covered materials.

C3
The course provides students with the opportunity to work with functions represented in a variety of ways – graphically, numerically, analytically, and verbally – and emphasizes the connections among these representations.

Points will be given for the completion of assignments, projects, quizzes, and tests. Tests will be given at the end of each chapter and/or major concept. Quizzes will be used to assess in a short amount of time the understanding of concepts. By spiraling the material we quiz and test on, we will continually reinforce previous concepts. Questions from released AP Calculus AB tests and support materials from the text will be used to develop the assessments. Tests and quizzes will have both multiple choice and free response questions and be modeled and graded in the same format as the AP test. Some questions will require the use of a calculator, while others will not.

Each student is expected to take the AP exam in place of a final exam for the course. Taking the AP exam will exempt the student from taking a final exam. If a student does not take the AP exam, they will receive an F as their grade for the final exam (which will impact their overall course grade) and will be responsible for reimbursing the cost of the exam (approximately $100). No additional final exam opportunity will be given outside of the scheduled AP exam.

Resources: (R1)

R1
The school ensures that each student has a college level calculus textbook (supplemented when necessary to meet the curricular requirements) for individual use inside and outside of the classroom

Calculus of a Single Variable (9th Edition) Houghton Mifflin Company by Ron Larson. Robert P. Hostetler and Bruce H. Edwards

Single Variable Calculus with Analytical Geometry Early Transcendentals (5^{th} edition) Prentice Hall by C. Henry Edwards and David E Penney

Multiple Choice & Free-Response Questions in Preparation for the AP Calculus (AB) Examination (7^{th} Edition) D & S Marketing System, Inc. by David Lederman

Calculus Graphical, Numerical, Algebraic Prentice Hall, by Finney, Demana, Waits, Kennedy

Cracking the AP Calculus AB & BC Exams The Princeton Review, by David Kahn

How to Prepare for the AP Calculus Exam by Shirley O. Hocket and David Bock

Variable Calculus: Early Transcendentals by James Stewart

Single Variable Calculus; Early Transcendentals by Jon Ragawski

Calculus Prentice Hall 1995 by Gerald Bradley and Karl Smith

Calculus with Analytical Geometry (5^{th} Ed) DC Heath and Co by Larson, Hostetler, Edwards

Course Syllabus: AP Calculus AB

Textbook Section / Objective

C2
The course teaches all topics associated with Functions, Graphs and Limits; Derivatives; and Integrals as delineated in the Calculus AB Topic Outline in the AP Calculus course description

Chapter P – Preparation for Calculus (C2) **Scheduled Time: 20 days**

P.1 Graphs and Models

- Sketch the graph of an equation
- Find the intercepts of a graph
- Test a graph for symmetry with respect to an axis and the origin
- Find the points of intersection of two graphs

P.2 Linear Models and Rates of Change

- Finding the slope of a line passing through two points
- Write the equation of a line with a given point and slope
- Interpret slope as a ratio or as a rate in a real-life application
- Sketch the graph of a linear equation in slope-intercept form

P.3 Functions and Their Graphs

- Use function notation to represent and evaluate a function
- Find the domain and range of a function
- Sketch the graph of a function
- Identify different types of transformations of functions
- Classify functions and recognize combinations of functions

Trigonometry Review

- Review of the unit circle and exact values
- Sketch graphs of Trig functions; take note of changes in period, amplitude, phase shifts and vertical shifts
- Identify and use Trigonometric identities

1.1 A Preview of Calculus (C2) **Scheduled Time: 15 days**

- Understand what calculus is and how it compares to precalculus
- Understand that the tangent line problem is basic to calculus
- Understand that the area problem is also basic to calculus

1.2 Finding Limits Graphically and Numerically

- Estimate a limit using a numerical or graphical approach
- Learn different ways that a limit can fail to exist
- Study and use a formal definition of a limit

1.3 Evaluating Limits Analytically

- Evaluate a limit using properties of limits
- Develop and use a strategy for finding limits
- Evaluate a limit using dividing out and rationalizing techniques
- Evaluate a limit using the Squeeze Theorem

1.4 Continuity and One-Sided Limits

- Determine continuity at a point and continuity on an open interval
- Determine one-sided limits and continuity on a closed interval
- Use properties of continuity
- Understand and use the Intermediate Value Theorem

1.5 Infinite Limits

- Determine infinite limits from the left and from the right
- Find and sketch the vertical asymptotes of the graph of a function

Chapter 2 – Differentiation (C2) **Scheduled Time: 20 days**

2.1 The Derivative and the Tangent Line Problem

- Find the slope of the tangent line to a curve at a point
- Use the limit definition to find the derivative of a function
- Understand the relationship between differentiation and continuity

2.2 Basic Differentiation Rules and Rates of Change

- Find the derivative of a function using the Constant Rule
- Find the derivative of a function using the Power Rule
- Find the derivative of a function using the Constant Multiple Rule
- Find the derivative of a function using the Sum and Difference Rule
- Find the derivative of the sine function and cosine function
- Use derivatives to find rates of change

2.3 The Product and Quotient Rules and Higher-Order Derivatives

- Find the derivative of a function using the Product Rule
- Find the derivative of a function using the Quotient Rule
- Find the derivative of a trigonometric function
- Find a higher-order derivative of a function

2.4 The Chain Rule

- Find the derivative of a composite function using the Chain Rule
- Find the derivative of a function using the General Power Rule
- Simplify the derivative of a function using algebra
- Find the derivative of a trigonometric function using the Chain Rule

2.5 Implicit Differentiation

- Distinguish between functions written in implicit form and explicit form
- Use implicit differentiation to find the derivative of a function

2.6 Related Rates

- Find a related rate
- Use related rates to solve real-life problems

Chapter 3 – Applications of Differentiation (C2) **Scheduled time 20 days**

3.1 Extrema on an Interval

- Understand the definition of extrema of a function on an interval
- Understand the definition of relative extrema of a function on an open interval
- Find extrema on a closed interval

3.2 Rolle's Theorem and the Mean Value Theorem

- Understand and use Rolle's Theorem
- Understand and use the Mean Value Theorem

3.3 Increasing and Decreasing Functions and the First Derivative Test

- Determine intervals on which a function is increasing or decreasing
- Apply the First Derivative Test to find relative extrema of a function

3.4 Concavity and the Second Derivative Test

- Determine intervals on which a function is concave upward or concave downward
- Find any points of inflection of the graph of a function
- Apply the Second Derivative Test to find relative extrema of a function

3.5 Limits at Infinity

- Determine (finite) limits at infinity
- Determine the horizontal asymptotes, if any, of the graph of a function
- Determine infinite limits at infinity

3.6 A Summary of Curve Sketching

- Analyze and sketch the graph of a function

3.7 Optimization Problems

- Solve applied minimum and maximum problems

3.8 Newton's Method

- Approximate a zero of a function using Newton's Method

3.9 Differentials

- Understand the concept of a tangent line approximation
- Compare the value of the differential, dy, with the actual change in y, Δy
- Estimate a propagation error using a differential
- Find the differential of a function using differentiation formulas

Chapter 4 – Integration (C2) **Scheduled Time 20 days**

4.1 Antiderivatives and Indefinite Integrals

- Write the general solution of a differential equation
- Use indefinite integral notation for antiderivatives
- Use basic integration rules to find antiderivatives
- Find a particular solution of a differential equation

4.2 Area

- Use sigma notation to write and evaluate a sum
- Understand the concept of area
- Approximate the area of a plane region
- Find the area of a plane region using limits

4.3 Riemann Sums and Definite Integrals

- Understand the definition of a Riemann sum
- Evaluate a definite integral using limits
- Evaluate a definite integral using properties of definite integrals

4.4 The Fundamental Theorem of Calculus

- Evaluate a definite integral using the Fundamental Theorem of Calculus
- Understand and use the Mean Value Theorem for Integrals
- Find the average value of a function over a closed interval
- Understand and use the Second Fundamental Theorem of Calculus

4.5 Integration by Substitution

- Use pattern recognition to evaluate an indefinite integral
- Use a change of variables to evaluate an indefinite integral
- Use the General Power Rule for Integration to evaluate an indefinite integral
- Use a change of variables to evaluate a definite integral
- Evaluate a definite integral involving an even or odd function

4.6 Numerical Integration

- Approximate a definite integral using the Trapezoidal Rule
- Approximate a definite integral using Simpson's Rule
- Analyze the approximate error in the Trapezoidal Rule and in Simpson's Rule

Chapter 5 – Applications of Integration (C2) **Scheduled Time: 25 days**

5.1 The Natural Logarithmic Function: Differentiation

- Develop and use properties of the natural logarithmic function
- Understand the definition of the number e
- Find derivatives of functions involving the natural logarithmic function

5.2 The Natural Logarithmic Function: Integration

- Use the Log Rule for Integration to integrate a rational function
- Integrate trigonometric functions

5.3 Inverse Functions

- Verify that one function is the inverse function of another function
- Determine whether a function has an inverse function
- Find the derivative of an inverse function

5.4 Exponential Functions: Differentiation and Integration

- Develop properties of the natural exponential function
- Differentiate natural exponential functions
- Integrate natural exponential functions

5.5 Bases Other Than e and Applications

- Differentiate exponential functions that have bases other than e
- Differentiate and integrate exponential functions than have bases other than e
- Use exponential functions to model compound interest and exponential growth

5.6 Differential Equations: Growth and Decay

- Use separation of variables to solve a simple differential equation
- Use exponential functions to model growth and decay in applied applications

5.7 Differential Equations: Separation of Variables

- Use initial conditions to find particular solutions of differential equations
- Recognize and solve differential equations that can be solved by separation of variables

5.8 Inverse Trigonometric Functions: Differentiation

- Develop properties of the six inverse trigonometric functions
- Differentiate an inverse trigonometric function
- Review the basic differentiation formulas for elementary functions

5.9 Inverse Trigonometric Functions: Integration

- Integrate functions whose antiderivatives involve inverse trigonometric functions
- Review the basic integration formulas involving elementary functions

Chapter 6 – Applications of Integration (C2) Scheduled Time: 20 days

6.1 Area of a Region Between Two Curves

- Find the area of a region between two curves using integration
- Find the area of a region between intersecting curves using integration
- Describe integration as an accumulation process

6.2 Volume: The Disk Method

- Find the volume of a solid of revolution using the disk method
- Find the volume of a solid of revolution using the washer method
- Find the volume of a solid with known cross sections

6.3 Volume: The Shell Method

- Find the volume of a solid of revolution using the shell method
- Compare the uses of the disk method and the shell method

Chapter 7 – Integration Techniques, L'Hôpital's Rule, an d Improper Integrals (C2)

(Optional)

7.1 Basic Integration Rules

- Review procedures for fitting an integrand to one of the basic integration rules

7.7 Indeterminate Forms and L'Hôpital's Rule

- Recognize limits that produce indeterminate forms
  Apply L'Hôpital's Rule to evaluate a limit

Remainder of course time will be spent reviewing and preparing for the AP Exams.