AP Calculus AB Syllabus
Curricular Requirements

CR1a – The course is structured around the enduring understandings within Big Idea 1: Limits.
See page 3, 5, 8
CR1b – The course is structured around the enduring understandings within Big Idea 2: Derivatives.
See page 4, 5, 8,
CR1c – The course is structured around the enduring understandings within Big Idea 3: Integrals and the Fundamental Theorem of Calculus.
See page 6, 7, 9
CR2a – The course provides opportunities for students to reason with definitions and theorems.
See page 4, 6,
CR2b – The course provides opportunities for students to connect concepts and processes.
See page 3, 5, 6, 8, 9
CR2c – The course provides opportunities for students to implement algebraic/computational processes.
See page 3, 4
CR2d – The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.
See page 5, 6,
CR2e – The course provides opportunities for students to build notational fluency.
See page 2, 7, 8
CR2f – The course provides opportunities for students to communicate mathematical Ideas in words, both orally and in writing.
See page 2, 4, 6,
CR3a – Students have access to graphing calculators.
See page 2
CR3b – Students have opportunities to use calculators to solve problems.
See page 7
CR3c – Students have opportunities to use a graphing calculator to explore and interpret calculus concepts.
See page 3, 5, 6,
CR4 – Students and teachers have access to a college-level calculus textbook.
See page 2

Brief Description of Course

AP Calculus consists of coursework that is comparable to calculus courses offered at colleges and universities. Students who take the course will be prepared to seek college credit through the College Board Advanced Placement Exam for Calculus AB, which gives a semester credit at most universities. The course contents include the study of functions, graphs and limits, derivatives, integrals and the applications of each. The course emphasizes a multi-representational approach to calculus, with concepts, results, and problems, expressed graphically, numerically, analytically, and verbally. There is an emphasis placed on the connections among these representations. The course contents are demanding and require work both in and outside class, as would any college course. AP Calculus AB gives students a chance to bring together concepts from previous math courses, used in new and challenging ways, and should provide students with a strong foundation for courses they will take in

college.

All students will be issued the textbook: Larson, Edwards Calculus of a Single Variable, 10e, Cengage Learning [CR4].

> [CR4] – Students and teachers have access to a college-level calculus textbook.

All students will have a TI-84 calculator or will have access to one in the classroom everyday [CR3]. Each student will also have a Chromebook assigned through the school so that they have access to the internet and other course ebooks at any time.

> [CR3] – Students have access to graphing calculators and opportunities to use them to solve problems and to explore and interpret calculus concepts

Throughout the course, Problem Sessions will be assigned weekly. They will consist of 2 AP free response questions from past AP Exams. They will relate to what students have been learning, as close as possible. The last Problem Session each grading period will consist of multiple - choice questions only (if available). Problem Sessions will be handed out each Monday and students will have one week to complete them. Problem Sessions will be graded using AP grading methods. Proper notation [CR2e] and written justification [CR2f] is required in work and in final answers. Students will receive a scoring guideline to show how many points are needed for each score.

> [CR2e] – The course provides opportunities for students to build notational fluency.
>
> [CR2f] – The course provides opportunities for students to communicate mathematical Ideas in words, both orally and in writing.

A timed AP Quiz will be given on the day students turn in your Problem Sessions. This will consist of one AP Free Response Problem from previous AP Exams. Students will have 20 minutes to complete the quiz. Proper notation [CR2e] and written justification [CR2f] is required in work and in final answers. These will be graded on an AP scale and count as daily grades.

> [CR2e] – The course provides opportunities for students to build notational fluency.
>
> [CR2f] – The course provides opportunities for students to communicate mathematical Ideas in words, both orally and in writing.

All answers given on homework assignments, problem sessions, quizzes and tests will be written AP style. If a sentence or written justification is required, then the answer will be expected to have the correct AP style written response. [CR2f] As students work individually and in groups, they will be expected to explain/discuss the concept they are working on to the teacher or to one another. [CR2f]

> [CR2f] – The course provides opportunities for students to communicate mathematical Ideas in words, both orally and in writing.

Course Outline

PRECALCULUS REVIEW (1 Week – One Test (included in Limit Test 1))

- Parent functions and their attributes
- Trigonometric Functions and Values

- Function Properties
- Piece-Wise Functions
- Graphical Models
- These concepts will all be covered using a various handouts

LIMITS AND THEIR PROPERTIES [CR1a] **(Chapter 1 – 2 Weeks – Two Tests)**

[CR1a] The course is structured around the enduring understandings within Big Idea 1: Limits

- Lab on limits: Students start with a function, a table of preselected x values (they find the y-values), and a calculator [CR3c] to discover what a limit is. Then the student creates the table, and graphs a function to see what a limit does.

  [CR3c] – Students have opportunities to use a graphing calculator to explore and interpret calculus concepts.

- Introduction to limits using an intuitive understanding of the limit process
- Finding limits graphically and numerically using tables (section 1.2 Finding Limits Graphically and Numerically) [CR2d]

  [CR2d] – The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.

- Properties of limits (subsection of section 1.3)
- Evaluating limits analytically and algebraically (section 1.3) [CR2c, CR2d]

  [CR2c] – The course provides opportunities for students to implement algebraic/computational processes.

  [CR2d] – The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.

- Comparing relative magnitudes of functions and their rates of change
- Continuity and one-sided limits, including an intuitive understanding of continuity (section 1.4 Continuity and One-sided Limits)
- Geometric understanding of the graphs of continuous functions
- Intermediate and Extreme Value Theorems (section 1.4)
- Infinite limits (section 1.5)
- Using limits to find asymptotes of a function and understanding asymptotic behavior of a graph
- Understanding the use of L'Hospital's Rule for limits of indeterminate form (section 8.7)

  Sample Activity: Limits and Continuity Activity – Students will work in groups, they will have 32 cards to sort through where they will match an equation, graph, verbal description, and a limit. [CR2d] There are 8 sets to match. [CR2b]

  [CR2d] – The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.

[CR2b] – The course provides opportunities for students to connect concepts and processes.

Sample Activity: Writing about Limits and Continuity Activity – Students will be given different graphs of either functions or derivatives and using at least 10 preselected vocabulary words write a paragraph describing each graph with all 10 words. [CR2a] Each graph will use different vocabulary words i.e. increasing/decreasing, tangent, slope, infinity, relative maximum, (continuous, limit, domain, approaches), etc. Students will share with the class what they have written. [CR2f]

[CR2a] – The course provides opportunities for students to reason with definitions and theorems.

[CR2f] – The course provides opportunities for students to communicate mathematical Ideas in words, both orally and in writing.

Sample Activity: Students will work in groups to complete *Joys of the Intermediate Value Theorem* by James Tanton to gain a deeper understanding of the application possibilities of the Intermediate Value Theorem. [CR2a]

[CR2a] – The course provides opportunities for students to reason with definitions and theorems.

DERIVATIVES [CR1b] **(Chapter 2 – 6 Weeks – Four Tests)**

[CR1b] – The course is structured around the enduring understandings within Big Idea 2: Derivatives.

- Zooming in Activity using local linearity
- Understanding the derivative graphically, analytically, and numerically
- Finding rates of change from tables of data and graphs
- Understanding derivatives as average rates of change and instantaneous rates of change
- Understanding derivatives as the limit of the difference quotient (subsection of section 2.1 The Derivative)
- Finding the slope of the curve at a point (subsection of section 2.1 The Tangent Line Problem)
- Understanding the meaning of the derivative by translating verbal descriptions into equations and equations into verbal descriptions
- The relationship between differentiability and continuity (subsection of section 2.1 Differentiability and Continuity)
- Functions with vertical tangents at a point (subsection of section 2.1 A graph with a Vertical Tangent Line)
- Functions with points at which there are no tangents (section 2.1)
- Differentiation rules for basic functions, including trig and power functions (section 2.2 Basic Differentiation Rules and Rates of Change) [CR2c]

[CR2c] – The course provides opportunities for students to implement algebraic/computational processes.

- Differentiation rules for sums, differences, products, and quotients (sections 2.2 and 2.3 Product

and Quotient Rules and Higher-Order Derivatives) [CR2c]

[CR2c] – The course provides opportunities for students to implement algebraic/computational processes.

- The Chain Rule (section 2.4)
- Finding derivatives using the calculator[CR3]
- Implicit differentiation (section 2.5)
- Related rates (section 2.6)

Sample Activity: Teacher Guided Zooming in Activity – Students start with three unknown functions that are graphed on a calculator but zoomed tightly so that they can find the slope (local linearity). The students find the slope of each "line". The three functions are revealed to be non linear functions. Teacher/student discussion about what they were seeing. [CR2b] (Adapted from: The Derivative http://apcentral.collegeboard.com/apc/members/courses/teachers_corner/42248.html)

[CR2b] – The course provides opportunities for students to connect concepts and processes.

Sample Activity: Graphing Calculator Activity *Derivative of a Function & Discovery of Power Rule* This activity will walk students through investigations of the value of the slope of a tangent line to polynomial curves at various points. An instantaneous scatter plot will be generated so that the students will discover that they can not only investigate derivatives of various polynomials, but that the derivatives themselves are in fact functions also. [CR2d, CR3c]

[CR2d] – The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.

[CR3c] – Students have opportunities to use a graphing calculator to explore and interpret calculus concepts.

APPLICATIONS OF DERIVATIVES [CR1a, CR1b] **(Chapter 3 – 7 Weeks – Two Tests)**

[CR1a] – The course is structured around the enduring understandings within Big Idea 1: Limits.

[CR1b] – The course is structured around the enduring understandings within Big Idea 2: Derivatives.

- Extrema (relative and absolute) on an interval (section 3.1 Extrema on an Interval)
- Use AP – CM Calculus Extrema Module
- Rolle's Theorem and the Mean Value Theorem and their geometric consequences (section 3.2 Rolle's Theorem and the Mean Value Theorem)
- First Derivative Test (subsection of section 3.3 The First Derivative Test)
- Increasing and decreasing functions and the First Derivative Test (subsection of section 3.3 Increasing and Decreasing Functions)
- Concavity and points of inflection (subsection of section 3.4 Concavity, Points of Inflection)

- Concavity of a function and its relationship to first and second derivatives (section 3.4)
- Second Derivative Test (subsection of section 3.4 The Second Derivative Test)
- Limits at Infinity (section 3.5 in textbook)
- Curve Sketching using geometric and analytic information, as well as calculus to predict behavior of a function (section 3.6 in textbook)
- The relationship between f, f', and f", including characteristics of the graphs of each (section 3.6 Analyzing the Graph of a Function)
- Card sort: matching graphs of f, f', and f"
- Optimization (section 3.7 Optimization Problems)
- Tangent line to a curve, and linear approximations (subsection of 3.9 Tangent Line Approximations)
- Application problems including rectilinear motion, position, velocity, and acceleration [CR2b]

[CR2b] – The course provides opportunities for students to connect concepts and processes.

Sample Activity: Writing about Graphs Activity – Students will be given different graphs of either functions or derivatives and using at least 10 preselected vocabulary words write a paragraph describing each graph with all 10 words. [CR2a, CR2d] Each graph will use different vocabulary words i.e. increasing/decreasing, tangent, slope, infinity, relative maximum, (continuous, limit, domain, approaches), etc. Students will share with the class what they have written. [CR2f]

[CR2a] – The course provides opportunities for students to reason with definitions and theorems.

[CR2d] – The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.

[CR2f] – The course provides opportunities for students to communicate mathematical Ideas in words, both orally and in writing.

Sample Activity: *Move My Way* Students will use a Calculator-Based RangerTM (CBRTM) data collection device with a graphing calculator to collect motion data with certain characteristics and use that data to draw conclusions about the relationship between position and velocity. [CR3c] Because velocity is the derivative of displacement, taking a closer look at position and velocity can develop a deeper understanding of how derivatives and their functions are related. [CR2d]

[CR2d] – The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.

[CR3c] – Students have opportunities to use a graphing calculator to explore and interpret calculus concepts.

INTEGRATION [CR1c] **(Chapter 4 – 6 weeks – Three Tests)**

[CR1c] – The course is structured around the enduring understandings within Big Idea 3: Integrals and the Fundamental Theorem of Calculus.

- Introduction to integration as an accumulator: begin with a constant function and work up to a curve discussing how to accumulate along the way.
- Antiderivatives and indefinite integration, including antiderivatives following directly from derivatives of basic functions (section 4.1 Antiderivatives and Indefinite Integration)
- Basic properties of definite integrals (section 4.1)
- Area under the curve (subsection of section 4.2 The Area of a Plane Region)
- Meaning of definite integral and its properties (section 4.3 Reimann Sums and Definite Integrals)
- Definite integral as a limit of a Riemann Sum (section 4.3)
- Riemann sums, including left, right, and midpoint sums (section 4.3)
- Trapezoidal sums (section 4.3)
- Use Riemann sums and trapezoidal sums to approximate definite integrals of functions represented by tables of data, graphically, and algebraically
- Use the First Fundamental Theorem of Calculus to evaluate definite integrals (section 4.4 The Fundamental Theorem of Calculus)
- Fundamental Theorem Activity
- Use substitution of variables to find antiderivatives and to evaluate definite integrals, including change of limits of integration (section 4.5 Integration by Substitution)
- Integration by Substitution Activity
- Use the Second Fundamental Theorem of Calculus in relation to functions defined by integrals (subsection of section 4.4 The Second Fundamental Theorem of Calculus)
- Mean Value Theorem for Integrals and the Average Value of a Function (subsection of section 4.4 The Mean Value Theorem for Integrals)
- Find integrals on a calculator [CR3b]

[CR3b] – Students have opportunities to use calculators to solve problems.

Sample Activity: Reimann Sums to Definite Integral – Students write an expression for an approximation of the area between the horizontal axis and the graph of $f(x)$ for a particular function given as a formula on a specified interval as a left, right, and midpoint Riemann sum using n subdivisions. They then use a Desmos graph with slider to explore sums. The file superimposes rectangular areas on the graph of $f(x)$, showing the sum value. The software allows for left, right, and midpoint sums. The slider increases the number of partitions to explore precision. Finally, students write limits of their Riemann suns as n goes to infinity, then identify each as a definite integral, and use the Fundamental Theorem of Calculus to evaluate the integral. [CR2e]

[CR2e] – The course provides opportunities for students to build notational fluency.

Sample Activity: Worksheet – Discovering the Fundamental Theorem of Calculus: Students will work through several integration problems both graphically and analytically until they notice that the area under the function is the accumulation: *accumulation @b – accumulation @a.*
From this activity, students will see the connection to $\int_a^b f'(x)dx = f(b) - f(a)$. [CR1c]

[CR1c] – The syllabus must specifically mention integrals and both parts of the Fundamental Theorem of Calculus.

Sample Activity: Integration by Substitution – Students will be given color coded cards where

they will define u , find the correct dx = card, match the correct rewrite card w/u du, integrate and solve, and then finally match the solution card. [CR2b]

[CR2b] – The course provides opportunities for students to connect concepts and processes.

Sample Activity: Fundamental Theorem Activity – Students are given a lab of past free-response questions in which they must use the Fundamental Theorem of Calculus. Within these problems, they are often required to calculate a definite integral with their calculators. In addition, they must answer questions about extrema and inflection points of *g* using calculus if given a function $g(x) = \int_a^x f(t)\,dt$ [CR2e] and a graph of *f*.

[CR2e] – The course provides opportunities for students to build notational fluency.

LOGARITHMIC, EXPONENTIAL, AND OTHER TRANSCENDENTAL FUNCTIONS [CR1b, CR1a] **(Chapter 5 – 2 Weeks – Two Tests)**

[CR1a] – The course is structured around the enduring understandings within Big Idea 1: Limits.

[CR1b] – The course is structured around the enduring understandings within Big Idea 2: Derivatives.

- The natural logarithmic function and differentiation (section 5.1)
- The natural logarithmic function and integration (section 5.2)
- Inverse functions (section 5.3)
- Exponential functions, including differentiation and integration (section 5.4)
- Bases other than e and applications (section 5.5)
- card sort: matching derivatives and integrals with logs and exponential functions
- Inverse trig functions and differentiation (section 5.6)
- Inverse trig functions and integration (section 5.7)

DIFFERENTIAL EQUATIONS [CR1b] **(Chapter 6 – 1 Week – One Test)**

[CR1b] – The course is structured around the enduring understandings within Big Idea 2: Derivatives.

- Solving separable differential equations (section 6.3 Separation of Variables)
- Applications of differential equations, including exponential growth (section 6.2 Differential Equations: growth and decay)
- Introduction to slope fields
- Use of slope fields to interpret a differential equation geometrically (section 6.1 Slope Fields and Euler's Method)
- Drawing slope fields and solution curves for differential equations (section 6.1)

Sample Activity: Introduction to Slope Fields activity – Create a class slope field—each student will draw their slope at a given point. When all students have placed the "slopes" on a common graph, they will see the slope field and we will talk about what was created. (Adapted from http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/11871.html) [CR2b]

[CR2b] – The course provides opportunities for students to connect concepts and processes.

APPLICATIONS OF INTEGRATION [CR1c] **(Chapter 7 – 3 Weeks – Two Tests)**

[CR1c] – The course is structured around the enduring understandings within Big Idea 3: Integrals and the Fundamental Theorem of Calculus.

- Motion along a line, including total distance traveled by a particle (subsection of section 4.4 solving a particle motion problem)
- Use AP - CM Calculus Motion Module [CR2b]

[CR2b] – The course provides opportunities for students to connect concepts and processes.

- The integral as an accumulator of rates of change (subsection of section 7.1 integration as an accumulation process)
- Use AP – CM Calculus Reasoning from Tabular Data [CR2d]

[CR2b] – The course provides opportunities for students to connect concepts and processes.

- Area of a region between two curves (section 7.1)
- Volume of a solid with known cross sections (subsection of section 7.2 disk and washer methods)
- Volume of solids of revolution (subsection section 7.2)

REVIEW FOR AP EXAM (3 Weeks)

- Review packets on Derivatives and Integrals
- Practice AP Released Free Response Questions
- Practice Exam (Latest Released Multiple Choice and Free Response Questions)

NOTE: After the AP Exam, students have a choice of various projects that reinforce calculus concepts from the AP course.