2019--2020 COURSE SYLLABUS

AP Calculus AB Syllabus

Instructor:

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Textbook:

Calculus for AP, Ron Larson and Paul Battaglia, 2017 [**CR4]**

Supplemental Resources:

AP Central-Calculus (website)
Barron's AP Calculus Test Preparation (11th edition or later)
Fasttrack to a 5: Preparing for the AP Calculus AB and Calculus BC Examinations

Course Description:

This is a college-level Calculus course designed to meet the Advanced Placement curricular requirements to Calculus AB (equivalent to a one-semester college course). The major topics covered in this course are limits, derivatives, integrals, and the Fundamental Theorem of Calculus. These concepts will be developed using reasoning with definitions and theorems, algebraic and computational processes, and the use of graphing calculators when appropriate. Students in this class will be asked to demonstrate competency verbally, through writing, with notational fluency, and be required to connect concepts graphically, numerically, analytically, with tabular data, and through written words.

Technology Requirement:

Graphing calculators will be used in class and for at-home assignments regularly. All in-class calculator demonstrations will be on a TI-84, however, any AP-approved calculator is acceptable. Since scientific calculators are not permitted on the AP exam, their use will not be permitted in class. Most class assessments will include both a calculator and non-calculator exam. Those students who cannot provide their own calculator will be given the opportunity to check one out for the school year from the instructor **[CR3a]**.

Additional Support:

After school tutoring sessions will be held regularly on Wednesdays from 3:20-4:30pm. Students are welcome to come in for individual questions or may use the time to work on assignments within small groups of their peers with instructor clarification/assistance when needed. Additionally, AP review sessions will be scheduled during the second semester outside of instructional time to prepare for the AP exam as a group. Some of these review sessions may take place off campus.

Final Exams:

At the end of the first semester students will take a 2-hour final exam that mocks question types, time constraints, and grading standard of the AP Calculus exam. Prior to taking the AP exam students will take a full-length mock AP Calculus exam. These exams will be used to review and assess preparedness for the actual AP exam.

Grading Scale:

A	85-100%
B	75-84.9%
C	60-74.9%
D	50-59.9%
F	0-49.9%

Grading Categories:

70% Assessments
10% Assignments
20% Final Exam

Topic Outline:

Unit P: Precalculus and Trigonometry
- P1 Graphs and Models
- P2 Linear Models and Rates of Change
- P3 Functions and Their Graphs
- P4 Trigonometry and the Unit Circle
- P5 Exponential and Logarithmic Functions

Unit 1: Limits and Continuity **[CR1a]**
- 1.2 Finding Limits Graphically and Numerically
- 1.3 Evaluating Limits Analytically
- 1.4 Continuity and One-Sided Limits
- 1.5 Infinite Limits
- 1.6 Limits at Infinity

Unit 2: Derivatives **[CR1b]**
- 2.1 The Derivative and the Tangent Line Problem
- 2.2 Basic Differentiation Rules and Rates of Change
- 2.3 Product and Quotient Rules and Higher-Order Derivatives
- 2.4 The Chain Rule
- 2.5 Implicit Differentiation
- 2.6 Derivatives of Inverse Functions
- 2.7 Related Rates
- 7.7 Indeterminate Form and *L'Hôpital's* Rule

Unit 3: Applications of Derivatives **[CR1b]**
- 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
- 3.6 Optimization Problems
- 3.7 Differentials

Unit 4: Integrals **[CR1c]**

4.1 Antiderivatives and Indefinite Integration
4.2 Area
4.3 Riemann Sums and Definite Integrals
4.4 The Fundamental Theorem of Calculus
4.5 Integration by Substitution
4.6 The Natural Logarithmic Function: Integration
4.7 Inverse Trigonometric Functions: Integration
\+ Riemann Sums and Trapezoidal Sums with Unequal Subintervals

Unit 5: Differential Equations

5.1 Slope Fields
5.2 Growth and Decay
5.3 Separation of Variables

Unit 6: Volume

6.1 Area of a Region Between Two Curves
6.2 Volume: The Disk and Washer Methods
\+ Cross-Sectional Volume

Activities Relating to the Six Mathematical Practices and Technology Requirement:

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

- Given a table of values for a function or the derivative of a function, students will be asked such questions as ‘does the function have any zeros on the given interval’, ‘does the function reach a particular value on the given interval’, or ‘are there any points at which the function has a horizontal tangent line on the given interval’. These questions will require complete justification using the Intermediate Value Theorem, the Mean Value Theorem, or Rolle’s Theorem. Before applying these theorems, students must verify and indicate that all hypotheses of the theorem being used have been met in the given problem.
- Given the graph of the derivative of as function and a single value from the original function, students will have to apply the Fundamental Theorem of Calculus to find another value on the graph of the original function.
- Students will determine the relative extrema of a function by applying the First and Second Derivative Tests. Further, they will be able to justify verbally and in writing the reason their conclusion can be made. This will be done given the graph of the derivative of a function, or given a table of values regarding the original function and its derivative, or given the equation of the original function to determine all locations of the relative extrema.

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

- Students will be asked to sketch graphs of functions based on information given only about the derivatives of these functions.

- Students will have to solve a variety of accumulation problems by applying basic integrals and the Fundamental Theorem of Calculus.
- Students will regularly be asked to solve problems related to particle motion by applying derivatives, the average rate of change, indefinite and definite integrals.

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

- Students will regularly perform sophisticated algebraic simplification in derivative functions and indefinite integrals.
- Students will complete an activity that has them compute and compare left Riemann sums, right Riemann sums and trapezoidal sums.
- Students will apply formulas and compute volume of both solids of revolution and solids formed by defined cross sections.

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

- Students will be given problems describing a solid formed by defined cross sections in a region bound by the graphs of functions. For each of the problems they will be asked to draw and shade the region defined in the problem, to build a 3-dimensional model up from this two-dimensional region by making cross sections out of modeling clay, then write an expression containing one or more integrals that can be solved to find the volume of the solid built.
- Students will complete a “Reasoning with Tabular Data” activity in small groups in which they must use a table of data that represents some real-world situation. In this activity they will need to apply what they know about graphical analysis to generalize what can be determined about the graph of the function as a whole. They will also need to apply a variety of concepts such as Riemann sums, the average rate of change, the average value of the function, and the Fundamental Theorem of Calculus to solve problems written in only the context of the real world function itself. Lastly, they will be asked to combine the knowledge of the function deduced from the table with a related function given by its equation.
- In an activity that considers the functions f, f’, and f’’ in which one of those graphs is given, students will be asked to create a sign chart for each of the functions, then sketch a possible graph of each of the functions, then answer some graphical analysis questions about each of the functions and to justify their reasoning.

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

- Given the graph of a function $f(x)$, students will have to answer questions about the related function $g(x)=\int_0^x f(x)dx$ such as its value at a given value of x and the value of its derivative at a certain value of x.
- Students will be asked to translate growth/decay problems written in the form ‘the rate of

change of y is proportional to ____' into a separable differential equation of the form $\frac{dy}{dt} = ?$. In order to finish the in-context problem, they will need to solve their differential equation by separating the differentials dy and dt.

- Given the graph of a piecewise-defined function, students will have evaluate the one- and two-sided limits of the value of x that is the boundary of the domain of the different functions. They will then have to discuss the continuity of the function at this given value of x.

[CR2f] This course provided opportunities for students to communicate mathematical ideas in words, both orally and in writing.

- During lessons on the Mean Value Theorem and the Intermediate Value Theorem, students will be asked to justify whether a given problem satisfies the hypothesis of the theorem and how they were able to determine that.
- In the lesson about relative extrema, students will write full justifications of a relative maximum by stating that the first derivative has changed from positive to negative at a critical number. Orally, they will be asked to explain how this change in sign of the first derivative shows that the graph of f changes from increasing to decreasing at the critical number, and why the critical number warranted investigation.
- Within a lesson about applications of integrals, students will be asked to orally interpret given integral expressions within the context of particle motion, such as $\int_0^5 |v(t)|\,dt$ must be interpreted as the total distance traveled by the particle on the time interval [0, 5]. On assessments and assignments, students will be asked to write these same types of interpretations within the context of a given problem and include appropriate units.
- In partner discussions, given a graph of f, f', or f'', students will have to describe each of the characteristics they see on the graph and the interpretation of what that implicates about the related derivative and antiderivative graphs. This discussion will be followed by each student drawing a possible graph of the related derivative and antiderivative functions.
- When learning about limits students will be asked to give an oral description, in their own words, about the meaning of a limit in general and in the context of particular questions about limits that include graphs, tables of values, or functions. On limit assessments and assignments, students will be asked to interpret the meaning of limits that exist and limits that do not exist in complete sentences without using limit notation.
- In the lesson about continuity, students will be asked to describe the continuity of a function and the reasons for any discontinuities using the concept of the limit, then will have a follow-up written assignment in which they have to discuss continuity of given functions in the same way.
- Students will work in small groups on a Reasoning with Tabular Data activity in which they must discuss how to use given tables of data to analyze a function in context. This may include the average rate of change of the function, the accumulation of the function over a period of time, possibilities that the function or its rate of change reaches certain given values (Mean Value Theorem or Intermediate Value Theorem), etc. After discussing how to evaluate such things given only the table, students will be asked to write their solutions and

justification down, then present their findings to the class.

- After the AP exam, students will be assigned a project in which they must either present a Calculus lesson to the class or create a video lesson to be shown to the class. Their peers will then critique their lesson with a rubric that includes an evaluation of clarity of concept explanations, correct vocabulary usage, and thoroughness of all possible variations/errors that can occur in the lesson.

[CR3b and CR3c]

- Students will use graphing calculators to solve problems that involve graphing functions, calculating the zeros of a function, finding the intersection of functions, calculating the relative extrema of a function, calculating the derivative of a function at a point, graph the derivative of function, calculating a definite integral, and storing calculated values for later use.
- Students will graph the equation of a derivative for which they are unable to find the antiderivative with the techniques learned in this class. From their graph, they will create a sign chart for the derivative function, then make conclusions about the original function (such as its increasing/decreasing behavior, its concavity, and its relative extrema).
- Students will apply the Fundamental Theorem of Calculus to functions for which they cannot easily find the antiderivative by using the graphing calculator's ability to calculate definite integrals.
- In learning about infinite limits, students will use their graphing calculators to create a table of values for a function (this function must be complex enough as to not be able to be graphically visualized by the students without the use of technology) and then make a conjecture about the limit of the function as x approaches an asymptote or as x approaches ∞.

<u>Before learning the method of evaluating limits of rational functions that are undefined at a given value of x, students will use their graphing calculators to compare a table values for the function with the graph of the function and make conjectures about when the limit will exist.</u>