# AP® Calculus AB Course Syllabus

**DESCRIPTION OF COURSE:**

This course will cover the main ideas of study for AP Calculus: Limits and Continuity, Derivatives, Integrals and the Fundamental Theorem of Calculus. The primary text will provide a basic layout of the course. Students are to read and take personal notes on the text following directed instruction of the content. Throughout the course, students will be required to present the main ideas by use of 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.

**OBJECTIVE:**

Students will work collaboratively to understand each topic while the teacher provides guided examples and applications. Through exploration and discovery activities, students will gain the confidence to effectively communicate and reason with calculus concepts. Through labs and discussions students will discover and improve their understandings with the aid of technology. Through presentations, enduring understanding essential question prompts and AP® free response practice; students will express their calculus-based thought process and understanding verbally. Students will eventually become fluent in representing calculus concepts graphically, numerically, analytically, and verbally throughout this course.

**TECHNOLOGY:**

Throughout the course, students will be using their personal graphing calculators, laptops and class i-pads to assist in computation as well as exploration and manipulation. Technology gives a great advantage in being able to visually see and manipulate problems unlike before; e.g. shell-disk. Students will be expected to present formal problems as often as twice a month using the 'rule of four' as much as possible. The teacher will also guide students to being able to successfully write solutions to free response questions and analyze their peers work for error analysis. Emphasis is placed on inquiry and discussion of topics, multiple representations for solutions and technology as assistance. Students will be exposed to the *TI-Nspire* calculator application used on the teacher tablet PC and on the I-pad. Students will be performing calculator tasks such as graphing and computation and interpreting their results. At the end of each unit, students are to add their newly learned calculus capabilities to their calculator notes in their student binder. *'Calculus in Motion'* animations and videos will be used extensively to visualize many calculus concepts.

**EVALUATION TECHNIQUES:**

***Class work:*** Students will do their core learning in class along with the teacher and other students. Completion of class work is key to being successful in AP Calculus AB. Class work includes activities such as; assigned work problems, Technology- based labs, presentations, participation in discussion, and peer to peer tutoring. Students are expected to finish 100% of all class work.

***Homework:*** Students are expected to attempt all problems in the homework, and if unable to complete find the resources for support i.e. the internet, Google classroom forum, a peer or the teacher. Homework is graded solely by completion, not accuracy of work. High completion rates of homework often equate to high test scores.

***Projects:*** Students will be expected to turn in a variety of projects over the course of the semester. Projects range from using graphing programs to model functions to presenting calculus work applied in the real world context. Projects will start in class however students are expected to finish on their own time. The presentations of the project are essential. Therefore, students are required to turn in a written synopsis with an introduction and explanation of their project and prepared answers for their presentation. Projects generally will take 3-5 days to complete.

***Assessments:*** Students will be assessed formally through unit tests and gateway quizzes. Unit tests act as a summative assessment which will include questions from the lessons as well as questions from various AP Calculus AB exams. Gateway quizzes will be given as a formative assessment throughout each unit to ensure that students are retaining the content. Students must pass the gateway quiz with a C or above in order to move to the next concept. Corrections will be made on the Gateway quizzes until they have successfully and explicitly expressed all steps, notations, and reasoning for each problem correctly. Generally, assessments will be given as follows: 1 – 2 Gateway quizzes per unit, Unit tests at the culmination of each unit, Labs and projects at the culmination of every other unit when applicable.

<u>Mathematical Practices:</u>
Throughout the year the MPACs will be interwoven and applied through activities, labs and projects and classroom procedures. Here are some sample activities, and labs and classroom procedures that will allow students to apply the MPACS

| | |
|---|---|
| MPAC 1: Reasoning with definitions and theorems<br>Students will be required to present their problems from their classwork and homework on the board throughout the year. They must use mathematical terminology, theorems, conjectures and definitions so support their claims. Peers will then critique with the same level of reasoning after their presentations. | MPAC 4: Connecting multiple representations<br>When studying limits, students will be required explain the concept through algebraic, tabular, graphic and verbal expression. Students will complete an introduction graphing Lab of L'hopitals rule prior to directed instruction and will make conjectures as to why it works by examining graphical representation by the use of the calculator and zoom function in the TI-Nspire applet and in their handheld calculators. |
| MPAC 2: Connecting concepts<br>As a Function to Linear motion connection activity students will be required to match the concept as represented functionally to the correct concept for Linear Motion. | MPAC 5: Building notational fluency<br>For all homework activities and assignments/classwork and labs, students will be required to engage with notational expression and interpretation. |
| MPAC 3: Implementing algebraic/computational processes<br>When practicing AP released Multiple Choice, Free Response and on all class assessments, students will be required to show their thought process using calculus reasoning. Full credit will not be rewarded if this is omitted. Students will also be trained to use the calculator capabilities for computations. Although the calculator will complete the computation, they must be accurate and explicit with their commands for it to perform the correct computation. | MPAC 6: Communicating<br>Students will be required to present explanations and solutions to the daily DO NOW activities, class-work and homework assignments both orally and on in written form will be displayed on the board and in the google classroom, visible to all members of the class. Gateway quizzes and unit tests will include problems in which students are to explicitly justify their solution using calculus concepts in complete sentences. |

<u>Multiple Representations:</u>
Students will be expected to show their work analytically, numerically, graphically and verbally whenever possible. Activities such as formal presentations of work, small group discussions and graphing labs will give opportunities to the students to achieve this. At the start of the course the teacher will be modeling how to best show the rule of four, but by the midterm, students will be expected to write their solutions to free response questions rigorously.

<u>Primary Text:</u>
Larson, Ron and Bruce H. Edwards. <u>Calculus AP® Edition</u>. Belmont: Brooks/Cole, 2006. 9th Edition
Khan, David.

<u>Additional Resources</u>
- Cracking the AP® Calculus AB & BC Exams New York, 2012. 2013th Edition
- Barron's Guide to AP Calculus
- Google Classroom – An online forum for all classroom materials, announcements, discussions,

handouts and assignments
- TI-NSPIRE Application (I-pads)
- Geometer's Sketchpad Application (I-pad)

Calculator Usage:

Each student will have a personal TI 84+, TI 89 or TI-Nspire handheld calculator for frequent use in the course. The teacher will use the TI-Nspire for most calculator demos. The TI-NSPIRE app on the I-pads will also be used for collaborative classwork labs. Use of graphing calculators and graphing applications will be formally taught and students will be expected to use technology in class and on the assessments. Due to students various background in calculator use, there will be mini-lessons teaching student's use of calculator ranging from graphing lines to finding integrals. Calculators will be used to for their computational functions as well as their ability to graph functions and manipulate said graphs. Using the calculators daily, students will be able to better understand such topics as the flattening of curves into tangents and reducing the workload for topics such as series. The teacher will stress that good calculator skills are crucial in order to be able to understand and solve calculus level problems.

MAJOR CONCEPTS:

Throughout the year we will be focusing on three 'big ideas': Limits and Continuity, Derivatives, Integrals and the Fundamental Theorem of Calculus

*Each 'day' Constitutes 50 minutes of instructional time

*Unit 1 Limits and Their Properties- (~15 days)*

Students will develop an understanding of limits as the foundational building block for both derivatives and integration.

1. Intro Activity + Express and Interpret Limits
2. The Basics of Limits
3. Limits that Fail to exist
4. Evaluate Limits Analytically (Squeeze Theorem)
5. Strategies for finding Limits
6. One sided Limits & Continuity
7. Intermediate Value Theorem & It's Applications
8. Finding Limits at Infinity
9. L'hopital's Rule and Intermediate Forms

Example Activity: For some students this will be the first time that they will be finding limits. While graphically showing limits is beneficial, I find that students have a better understanding if they work numerically to find where the function is tending towards. Students work in groups on assigned problems in which they must use the graphing calculator as a tool to fill out table of values from raw data. They are then expected to write a verbose explanation of limits and their behavior and what it means in the real world context.

*Unit 2 Differentiation- (~20 days)*

Students will use their understanding of limits to explore the meaning of a derivative and instantaneous rate of change. Building on the limit definition of the derivative, students will explore and begin to use the various rules for taking a derivative. Students will be giving verbal and visual presentations using the rule of four to answer real-world problems (for example position and velocity) and give detailed explanations of numbers found.

1. Derivative and tangent line problem
2. Write an equation of the tangent line of nonlinear functions
3. The Derivative of a function
4. Differentiability & Continuity
5. Differentiation Rules

6. Rate of Change
7. Higher Order Derivatives
8. The Chain Rule
9. The General Power Rule
10. Simplifying Derivatives
11. Trig Functions + The Chain Rule

Example Activity: Students will focus on the verbal aspect of the changing of units in these problems and applications. This activity requires students to first write a detailed summary of the problem. What is exactly happening in the situation, what information is given, what is desired, etc. Once they have found the solution they are also required to write what the solution means in terms of the problem. Writing about the solution gives the students a better connection between the solution and the work. Students will also complete a graphing activity in which they will graph the $1^{st}$, $2^{nd}$ and $3^{rd}$ derivative in a column and describe what each derivative informs us about the function.

*Unit 3 Implicit Differentiation and Related Rates - (~12 Days)*
Students will expand on their understanding of derivatives and their use in real-world related rates problems. Students explore how to take derivatives of equations that are not mathematical functions using implicit differentiation. Students will take derivatives of an expression with relation to any variable, typically time with related rates problems. This unit tends to confuse students so we proceed slowly with lots of remediation and practice.

1. Implicit Differentiation
2. Finding Related Rates

Example Lab Activity:
To help aid in the process of solving related rates problems, students will explore the TI-Nspire related rates labs such as water draining out of a cylindrical tank or the change in volume and height of fluid in a vessel. Questions are presented in an open ended self-check format. Students will work with graphical and physical representations presented in the lab.

*Unit 4 Applications of Differentiation/Curve Sketching/Optimization-* (~12 days)
Students discover how we can use the first and second derivatives of functions to describe the function's behavior and sketch it accurately. Students will understand how to apply the Existence Theorems (which include the Intermediate Value Theorem, Extreme Value Theorem, Rolle's Theorem, and the Mean Value Theorem) to help problem solve and justify their conclusions.

1. The first Derivative Test
2. The Second Derivative Test
3. Extrema on an interval
4. Rolle's Theorem and the Mean Value Theorem
5. Existence Theorems Lab

Example Lab Activity:
Students will be given an Existence theorem Lab in which they are to verbally describe what each theorem tells us, what the conditions are in order to apply the theorem and a sketch that represents the theorem. Students will then follow up with released multiple choice questions that involve the existence theorems.

*Unit 5 Integration and Accumulation and the Fundamental Theorem of Calculus (~ 20 Days)*
Students will discover the relationship between differentiation and integration as inverse operations. Students learn how to integrate functions and then, using the definite integral, learn how to "accumulate" in various real-world settings. As the quarter progresses they learn the importance of the Fundamental Theorem of Calculus and its many applications.

1. Anti-derivatives and Indefinite Integration
2. More Complex Integrals with U Substitution
3. Area under a curve
4. Riemann Sums and Definite Integrals
5. The Fundamental Theorem of Calculus
6. FTC – The definite Integral as a Function
7. The Average Value of a Function

Example Lab Activity:

Students will work in groups and be given a TI-Nspire Lab on the class set of iPad that covers applications of the FTC. They are to identify the graphical connections between a function and its accumulation function for a road trip application problem. They will compare the graph of a velocity function to the graph of the accumulation function, $A(t)$. Students will also use the graph to solve questions about the speed of a car at different times. Students will begin to recognize the original function as the derivative of the accumulation function. Using information from the accumulation function, they will find the equation for the antiderivative of the velocity function. Students recognize this function, the accumulation, as the distance traveled on the road trip. They will have to communicate the calculus concepts orally, verbally and analytically in their lab work worksheets.

*Unit 6 Transcendental Functions – Derivatives and integrals (~ 12 days)*

Students will build upon their knowledge of taking derivatives and integrating using transcendental functions. Students see how powerful the chain rule can be and how to apply it to this unit when taking various derivatives.

1. Intro - The definition of Euler's Number
2. The Natural Log and differentiation
3. The natural Log and Integration
4. Trigonometric Functions and their Integrals
5. Inverse Functions
6. Exponential Functions (Differentiation & Integration)
7. Bases other than e and Applications

Example Activity:

Through tabular exploration students will discover the limit $\lim_{x\to\infty}\left(1+\frac{1}{x}\right)^x \to \lim_{x\to\infty}\left(\frac{x+1}{x}\right)^x = e$ (Theorem 5.15) and then work in groups to formulate a proof to relate the compounded interest formula with the continuously compounded interest formula. Using Kagan cooperative learning techniques such as 'Round Robin' each student in the group will have a chance to contribute to the proof.

*Unit 7 Differential Equations/Slope Fields (~10 days)*

Students will discover how to "read" a slope field to see how a function (or other equations that are not mathematical functions) behave. Students will also build upon their knowledge of integration, using separation of variables to solve more complicated Differential Equations.

1. Intro Activity - What is a slope field
2. Euler's Method
3. Slope Field Focus LAB
4. Differential Equations (Growth & Decay)
5. Separation of Variables
6. Differential Equations and Separation of Variables
7. Logistic Differential Equations

Example Activity

Students will be given various slope fields graphs and they are they are to work in pairs, matching the slope field with the appropriate associated Differential Equation or Function. Their reasoning will be expressed verbally using Kagan Techniques such as 'Think-Pair-Share'

Unit 8: *Area/Volume of a Revolution – Applications of Integration (~10 days)*

Students will discover the big picture of calculus in a variety of integration problems. Building upon their knowledge of accumulation (and specifically area under a curve), students will be able to find the area between two curves given two functions. Students also learn to find the volume of a solid when a function (or two functions) is rotated around a horizontal line or vertical line. Using a variety of geometric shapes, students will also be able to find the volume of a solid using known cross-sectional areas.

1. Area of a region between two curves
2. Volume: the disk method
3. Volume: The Shell Method*
4. Revolving Around the Y Axis
5. Revolving Around the any Horizontal or Vertical Line

Example Activity: Students will explore 3D items such as a stack of CDS, Oranges, Stack of Cards or a Choco pie and Donuts. They will examine the cross sections by cutting up their items. They will complete a food lab that will help derive the formulas for the integrals. Students will then make 3D models from assigned given cross sections, out of clay to present and display in the classroom.