Advanced Placement Calculus Syllabus- AB

Prerequisites
• All students should have completed four years of secondary mathematics designed for accelerated students. These should consist of the accelerated or honors track in algebra, geometry, trigonometry, analytical geometry, and elementary functions.

• All students placed in 240 AP Calculus must have received a final average of a B- from Accelerated Pre-Calculus or an A in Honors Pre-Calculus. An approved AP application is required. All AP applications are reviewed by a committee of accelerated math teachers. If a student is new to the school, they must take and receive the required grade on the departmental placement test in order to be placed in Course 240.

Technology requirement: It is essential that a student in this course own their own graphing calculator. Two sections of the AP exam require the use of one.
Preferred: TI-83 Plus Texas Instruments graphing calculator (alternative: TI-84, 86 or 83).

Students should have an excellent understanding of the following topics:

1. Functions :
    linear, trigonometric, logarithmic, polynomial, piece- wise defined, exponential
2. Properties of Functions:
    inverses,inverse trig, degree, frequency, amplitude, period of trig functions without a calculator, asymptotes (partial understanding), composition of functions, absolute value(...and how to write them as a piece- wise function), slope of line, equation of a line in the form: $y - y_1 = m(x - x_1)$, parallel, perpendicular, vertical, horizontal equations of lines
3. Algebra of Functions:
    synthetic division, simplifying with the conjugate, simplifying rational functions dividing functions w/long division
4. Graphs of Functions (without the use of any technology)
5. Language of Functions:
    domain and range, zeros, odd and even, periodic, symmetry(x-axis ,y-axis, origin only), intercepts, etc.
6. Values of the trigonometric functions of common angles such as : 0, $\pi/6$, $\pi/4$, $\pi/3$, and $\pi/2$ without the use of a calculator.

Course Content

*Prerequisite Quiz given within the first two weeks of school.
Prerequisite topics are listed above. A worksheet is reviewed beforehand. **(1-2 weeks)**

A. Graphing Calculator Competencies   (1-2 weeks)
1. General Information
2. Graphing and Calculations
    a. Modes

b. Zooms, Windows
c. Table, Calc commands
d. Math commands
e. Programming and Link
f. Top Ten Common Problems and several practice exercises
g. Graphing Calculator Lab: How does the TI graph?

B. Unit 1: Introduction to the Derivative   (5-6 weeks)
1. Average rate of change(slope of secant)
2. Instantaneous rate of change as a limit of the average rate of change
   a. Horizontal Tangents
   b. Displacement/Net Change
3. The Derivative
   a. Definition of the Derivative(Fermat's Method)
   b. Derivative notation
   c. Where f' does not exist
   d. Definition of differential calculus
   e. Absolute Value Derivatives
   f. Graphical relationships between f(x) and its derivative
4. Derivative Applications
   a. Distance functions vs. Displacement
   b. Average Rate of Change/Average Velocity
   c. Velocity vs. Speed
   d. Instantaneous Velocity
   e. Acceleration
   f. Tangents and Normal Lines
   g. Graphing Distance, Velocity, and Speed
5. The Limit
   a. Definition of a Limit(Cauncy)
   b. Finding Limits with a Graphing Calculator
   c. Limit Combination Theorem
   d. Right and Left Handed Limits
      i. Piece-wise functions, Absolute Values and Greatest Integer Functions
   e. The Sandwich Theorem
   f. Trig Limits
   g. Infinity Limits
   h. Limit Substitution
6. Continuity
   a. Definition with Continuity Test
   b. Theorems
      i. Limit Combination Theorem for Continuous Functions
      ii. Differentiable Functions and Continuity
      iii. Max-Min Theorem for Continuous Functions
      iv. Intermediate Value Theorem
   c. Continuous Extentions
   d. Definition of Critical Points and Absolute extrema values

7. Major Assessments
    a. Unit Test
    b. AP Problem Set #1(take-home test): collection of AP problems from past exams that pertain to the unit.

C. Unit 2: Rules and Theorems of the Derivative   (4-6 weeks)
1. Formulas for Taking the Derivative
    a. Power Rule
    b. Derivative of a Constant
    c. Coefficient Rule
    d. Sum Rule
    e. Product Rule
    f. Power Rule of a Differentiable Function
    g. Quotient Rule
    h. Second Derivative
2. Implicit Differentiation
    a. Power Rule for Fractional Exponents
    b. Independent and dependent variables
    c. Derivatives of Higher Order
3. Derivatives of Trig Fuinctions
4. Visualizing Solutions with Slope Fields
5. Linear Approximations
    a. Linearization/ Euler's Method
    b. Estimating Change with Differentials
6. The Natural Log
    a. Domain and Range
    b. Properties Review
    c. Derivative of the Natural log
7. Composition and Chain Rule
    a. Finding the derivative with three variables
    b. Composition and derivative given two graphs with three variables
    c. Parametric Equations
    d. 2nd Derivative with three variables
8. Functions with "e"
    a. Graph, Domain and Range
    b. Changing Logs to Exponential Form, "solving for y" Review
    c. Derivative of e^u
9. Inverses and Their Derivatives
    a. Finding Inverses
    b. Derivative Rule for Inverses
    c. Inverse Trig Values and Derivatives
10. Major Assessments
    a. Unit Test
    b. AP Problem Set #2(take-home test): collection of AP problems from past exams that pertain to the unit.

D. Unit 3: Applications of the Derivative   (4-5 weeks)
1. Curve Characteristics
    a. First Derivative Test
        i. Local and absolute extrema
        ii. Increasing and decreasing intervals
    b. Second Derivative Test
        i. Points of Inflection
        ii. Concavity intervals
    c. Second Derivative Test for Max/Mins
    d. Asymptotes(found with limits)
2. Optimization
3. Related Rates of Change
4. Theorems
    a. Rolle's Theorem
    b. Mean Value Theorem
    c. Max-Min Theorem for Continuous Functions(MVT Inequality)
5. L'Hopital's Rule
6. Major Assessments
    a. Unit Test
    b. AP Problem Set #3(take-home test): collection of AP problems from past exams that pertain to the unit.
    c. Mid-Year Exam: Covers the first three units of the course

E. Unit 4: The Anti- Derivative as a Summation   (4-5 weeks)
1. General Solution vs. Particular Solution
2. Indefinite Integral Notation
3. Integration Formulas
    a. Power rule
    b. w/ Coefficients
    c. w/ addition and subtraction
    d. Simple substitutions
4. Separating Variables
5. Finding "c" with initial conditions
6. Using Acceleration to find velocity to find position
7. Integrations of Trig Functions
8. The Definite Integral
    a. Approximating Definite Integrals
        i. Lower, Upper, Left, Right and Midpoint Riemann Sums
        ii. Trapezoidal Rule
    b. Algebraic Properties of Definite Integrals
    c. Fundamental Theorems of Calculus
        i. First FTOC
        ii. Second FTOC
    d. Finding Areas below a curve
9. Inverse Trig Integrations
10. Major Assessments

a. Unit Test
b. AP Problem Set #4(take-home test): collection of AP problems from past exams that pertain to the unit.

F. Unit 5: Applications of the Anti-Derivative   (4-5 weeks)
1. Distance/Velocity/ Acceleration Relationships
    a. Total Distance vs. Displacement
2. Area Between Curves
    a. "Top – Bottom"
    b. "Right – Left"
3. Volumes of Solids and Revolved Areas
    a. Volumes by Slicing
    b. Volumes with given cross-sections
    c. Volumes with washers
    d. Volumes with shells
4. Average Value of a Function
5. Integrations of Exponential Functions and ln u
    a. Integration of e^u, tan u, cot u
    b. Integration of a^u and $\log_a u$
6. Solving Differential Functions
7. Relative Rates of Growth
8. Major Assessments
    a. Unit Test
    b. AP Problem Set #5(take-home test): collection of AP problems from past exams that pertain to the unit.

G. Review for the AP Exam   (2-4 weeks)
1. Highlighting important information about the exam
2. Summaries of important concepts with AP problems to complete
3. Packet of Review Materials
    a. Vocabulary/concept fill-in
    b. Specific AP problems with answers
    c. Identifying types of problems
    d. How to prepare for the exam
    e. Review of any problem by request
4. Review Sessions(scheduled after school- usually the two days before the exam)

H. Technology Project   (from AP Exam to End of Year)
Two choices: Researching a New Math Topic
               OR Creating a Lesson by incorporating math software/technology

Student Outcomes
1. Students should be able to work with functions represented in a variety of ways:
    (a) graphical
    (b) numerical
    (c) analytical

(d) verbal
 They should understand the connections among these representations.

2. Students should understand the meaning of the derivative in terms of a rate of change and local linearization approximation and should be able to use derivatives to solve a variety of problems.

3. Students should <u>understand the meaning</u> of the definite integral both as a limit of the Reimann Sums and as the net accumulation of the rate of change and should be able to use the anti-derivative to solve a variety of problems.

4. Students should understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus.

5. Students should be able to communicate mathematics <u>both orally and in well-written sentences</u> and should be able to <u>explain solutions to problems.</u>

6. Students should be able <u>to model a written description of a physical situation</u> with a function, a differential equation, or an integral.

7. Students should be able to <u>use technology</u> to help solve problems, experiment, interpret results, and verify conclusions.

8. Students should be able to determine the reasonableness of solutions, including sign, size, relative accuracy, and units of measurement.

$\Rightarrow$ AP Calculus is an intensive mathematics course. I have high expectations for my students that can be reached when a consistent, good effort is applied. I assess my students on the understanding of concepts rather than process and product. In return, students gain an appreciation of Calculus as a coherent body of knowledge and as a human accomplishment.

* All students enrolled in the course are required to take the AP Calculus AB Exam in May. No student is allowed to drop the course after the first term.