MATHEMATICS DEPARTMENT

ADVANCED PLACEMENT CALCULUS (BC) SYLLABUS

Curricular Requirements

CR1a The course is structured around the enduring understandings within Big Idea 1: Limits.
- See page 2

CR1b The course is structured around the enduring understandings within Big Idea 2: Derivatives.
- See pages 2-3

CR1c The course is structured around the enduring understandings within Big Idea 3: Integrals and the Fundamental Theorem of Calculus.
- See page 3-4

CR1d The course is structured around the enduring understandings within Big Idea 4: Series.
- See page 4

CR2a The course provides opportunities for students to reason with definitions and theorems.
- See page 5

CR2b The course provides opportunities for students to connect concepts and processes.
- See page 5

CR2c The course provides opportunities for students to implement algebraic/computational processes.
- See page 5

CR2d The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.
- See page 5

CR2e The course provides opportunities for students to build notational fluency.
- See page 5

CR2f The course provides opportunities for students to communicate mathematical ideas in words, both orally and in writing.
- See page 5

CR3a Students have access to graphing calculators.
- See page 6

CR3b Students have opportunities to use calculators to solve problems.
- See page 6

CR3c Students have opportunities to use a graphing calculator to explore and interpret calculus concepts.
- See page 6

CR4 Students and teachers have access to a college-level calculus textbook.
- See page 6

Course Overview

Advanced Placement Calculus is a college level course for students with a high aptitude for Mathematics and above average achievement. The course covers the fundamentals of differential and integral calculus, and provides students with the opportunity to work with functions represented in a variety of ways: graphically, numerically, analytically, and verbally. There will be an emphasis placed on the literacy skills of reading, writing, speaking and reasoning. It is expected that students who take this course will seek college placement, college credit, or both, from institutions of higher learning.

Course Outline

Unit 1: Pre-Calculus Review

A. Properties of Algebraic and Trigonometric functions
   1. domain and range
   2. asymptotes and holes
   3. even and odd
   4. piecewise
   5. composite
   6. inverse functions

Unit 2: Limits and Continuity

A. Limits
   1. finding limits graphically and numerically
   2. evaluating limits analytically
   3. infinite limits
   4. one-sided limits

B. Continuity
   1. continuity at a point
   2. continuity on an interval
   3. Intermediate Value Theorem

Unit 3: Differentiation

A. Tangent lines
   1. local linearity
   2. approximating rate of change from graphs and tables of values

B. The derivative
   1. graphical explanation
   2. definition

C. Techniques of differentiation
   1. Power Rule
   2. Product Rule

3. Quotient Rule
4. Chain Rule

D. Higher order derivatives
1. Corresponding characteristics of the graphs of f, f', and f''

E. Implicit differentiation

F. Related Rate problems

Unit 4. Applications of the Derivative

A. Applications to graphing
1. increasing and decreasing
2. extrema of a function
3. relative maxima and minima
4. concavity
5. points of inflection
6. special cases
   a. cusps
   b. vertical tangent lines

B. Analyze and sketch the graph of a function

C. Mean Value Theorem and Rolle's Theorem

D. Optimization problems

E. Particle motion

F. Differentials
1. linear approximation
2. propagated error

Unit 5: Integration of Algebraic Functions

A. Antiderivatives and indefinite integration
B. Riemann sums and definite integrals
C. Fundamental Theorem of Calculus
D. Second Fundamental Theorem of Calculus
E. Average Value Theorem
F. Integration by substitution
G. Integration by Parts and Non-Repeating Linear Partial Fractions
H. Numerical integration
I. L'Hopital's Rule

Unit 6: Transcendental Functions

A. Natural Logarithmic function differentiation and integration
B. Inverse functions
C. Natural Exponential function differentiation and integration
D. Trigonometric function integration

Unit 7: Applications of Integrals

A. Area
   1. area between two curves
   2. *dx* slicing
   3. *dy* slicing
B. Volumes of solids of revolution
   1. disk method
   2. shell method
C. Volumes of solids with known cross sections
D. Arc Length and Surfaces of Revolution

Unit 8: Differential Equations

A. Slope fields
B. Growth and decay
C. Separation of variables
D. First-Order linear differential equations
E. Euler's Method

Unit 9: Infinite Series

A. Sequences
B. Series and Convergence/Divergence
C. The Integral Test an *p*-Series
D. The Ratio and Root Tests
E. Taylor Polynomials and Approximation
F. Power Series
G. Representing Functions by Power Series
H. Taylor Series
I. Maclaurin Series

Unit 10: Conics, Parametric Equations, and Polar Coordinates

A. Plane Curves and Parametric Equations
B. Parametric Equations
C. Polar Coordinates and Polar Graphs
D. Area and Arc Length in Polar Coordinates
E. Polar Equations of Conics and Kepler's Law

Review and Preparation for the AP Exam

Mathematical Practices

Reasoning with definitions and theorems- In problems where students practice applying the results of key theorems (e.g., Intermediate Value Theorem, Mean Value Theorems, and/or L'Hospital's Rule), students are required for each problem to demonstrate verbally and/or in writing that the conditions are met in order to use the theorem.

Connecting concepts and processes- Students can relate the concept of limits to other parts of the calculus. They can connect visual representations of concepts with and without technology, and identify common structures in different contexts. Students are provided with the graph of a function and a second function defined as the definite integral of the graphed function with a variable upper limit. Using differentiation and antidifferentiation, students evaluate specific values of the second function and then find the intervals where the integral function is increasing, decreasing, concave up, and concave down. They use this information to sketch a rough graph of the second function

Implementing algebraic/computational processes. Students can select appropriate algebraic and computational strategies. They can sequence and complete them correctly. They can apply technology, attend to precision analytically, numerically, graphically and verbally, and specify units of measure. Students will use multiple modes to calculate problems. Students are presented with a table of observations collected over time periods of different lengths. Students use Riemann sums to numerically approximate the average value of the readings over the given time period and interpret the meaning of that value

Engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them. Students are presented with numerous functions modeling velocity and time for objects in motion. These functions are presented numerically, graphically, analytically, and verbally. Given some initial conditions, students calculate or approximate displacement, total distance travelled, and acceleration for these functions (both by hand and with a graphing calculator).

Building notational fluency
Students are given a variety of growth and decay word problems where the rate of change of the dependent variable is proportional to the same variable (e.g., population growth, radioactive decay, continuously compounded interest, and/or Newton's law of cooling). Students are asked to translate the problem situation into a differential equation using proper notation. Students show the steps in solving the differential equation, continuing to use proper notation for each step (e.g., when to keep or remove absolute value). In a later activity, students will vary initial conditions and use their calculators to graph the resulting solutions so that students can explore the effect of these changes.

Communicating
Throughout the course, students are required to present solutions to homework problems both orally and on the board to the rest of the class. On at least one question on each quiz and test, students are explicitly instructed to include clearly written justifications in complete sentences for their solutions.

Primary Text

Larson, Hostetler, and Edwards. *Calculus of a Single Variable.* 8th ed. Boston: Houghton Mifflin Company, 2006.

Supplemental Texts

George W. Best and J. Richard Lux. *Preparing for the (AB) AP Calculus Examination.* Andover, MA: Venture Publishing, 2006.

David S. Kahn and Princeton Review. *Cracking the AP Calculus AB & BC Exams.* 2006-2007 ed. Random House Inc., 2006.

Technology Resources

Students are required to have a graphing calculator. The TI-89 is recommended and used on a daily basis along with its' companion view screen. A computer and SmartBoard are also located in the classroom and are used to access and display many of the interactive websites available online.

Calculator Use
Students will use their graphing calculators to explore concepts and check their understanding. All Students will have access to graphing calculators.

Students will use graphing calculators to discover topics including, but not limited to the following:
- Developing an intuitive understanding of limits
- Investigating the Intermediate Value Theorem
- Relationship between a function and its derivative
- Riemann sums and the definite integral
- Average value of a function
- Numerical integration

Assessment

Assessments used in this course include publisher and teacher made tests and quizzes, projects, pop-quizzes, homework assignments, classroom participation and class work.

- Tests are given at the end of each chapter of our primary text and are comprised of short-answer type questions from all previous chapters. The cumulative nature of these tests insures that each student is periodically exposed to each concept previously presented in the course. The questions are written to assess the students' ability to solve problems from a graphical, numerical, and analytical approach.
- Quizzes are given every other week and contain selected questions from the previous two weeks homework assignments. These quizzes help to insure that the students take their homework seriously, and clear up any questions they may have on homework assignments as soon as possible.
- Projects are assigned approximately every two weeks. Each project is a multipart free-response style question. The main goal of these projects is to familiarize each student with this type of question and what is expected from them in their solution. Each project is graded as it would be on an AP Exam.

This is a learning process designed to help students feel more comfortable with free-response style questions.

- Pop-quizzes are comprised of multiple-choice questions, and are given 1-2 times a week. The questions are chosen from our supplemental texts, and are designed to mimic multiple-choice questions that would be found on an AP Exam. The majority of pop-quizzes are given to the students as group quizzes. Here is where the verbal component of the course shines. The learning that goes on in these groups, and the communication that takes place is invaluable.
- Homework is assigned every day and is discussed the following day. Students are often called upon to present their solution to the class. The student will write their solution on the chalkboard, explain their thinking, and answer any questions there may be from others in the class (including the instructor). Here, again, the verbal component of learning calculus is strong.