

AP Calculus BC

Syllabus

Introduction:

Calculus is essentially the study of the relationships among changing quantities, and the curriculum of AP Calculus BC introduces the student to this study through single-variable functions.

Through exploration, class discussion, hands-on activities, and traditional lecture, students in this course will gain a better understanding of the foundational concepts of calculus so that they may be more successful in future mathematics courses.

This course, when applicable, approaches and connects the content in four ways – analytically, numerically, graphically, and verbally – and not through computational rules alone. Students also practice appropriate communication of the mathematics, be it written or verbal, particularly in explaining their solutions.

Prerequisites:

This course assumes all students have successfully completed the typical high school mathematics sequence through trigonometry and analytical geometry. Students who have earned credit in Precalculus meet this requirement. A firm background in the properties, algebraic manipulation, and graphing of elementary functions is critical, so these and other additional topics can be revisited and reinforced when appropriate.

Resources:

The primary textbook used in this course is *Calculus: Graphical, Numerical, Algebraic* by Finney, Demana, Waits, and Kennedy (Pearson Scott Foresman, 1999, ISBN 0-201-32445-8).

Other resources used to enhance the curriculum, where appropriate, are taken from printed materials, online resources, and activities shared among colleagues in the AP Calculus community.

Technology also plays an important part in this course, particularly with regard to problem solving, experimentation, and justification. Specifically, students will use graphing calculators to interpret results and support conclusions throughout the course. All students need access to a graphing calculator throughout the semester, and many activities require the use of various computer software programs and experimental hardware. All of these can be provided to the student as needed.

Course Plan:

Below is an outline of the topics presented in this course along with the approximate time spent on each unit.

Unit 1 – Limits and Continuity (3 weeks)

- Function Representations
 - analytical, graphical, numerical, and verbal
- Concept of a Limit
 - numerical and graphical approaches
 - one-sided limits
- Limit Evaluation
 - analytical approaches
- Infinite Limits
 - definition of vertical asymptotes
 - end-behavior
- Continuity
 - limit definition
 - graphical representation
 - Intermediate Value Theorem
- Assessments
 - limit activity (calculator – interpretation of results)
 - Boyle's Law lab (calculator experiment)
 - quizzes and exam

Unit 2 – Derivatives (3 weeks)

- Concept of a Numerical Derivative
 - slope of the tangent line to a curve at a point
 - limit definition
 - average and instantaneous rates of change
- Concept of a Function Derivative
 - limit definition
 - relationships among f , f' , and f''
 - connections to derivatives and their graphs
- Differentiability
 - limit definitions
 - graphical representation
 - relationship with continuity
- Assessments
 - graphing exploration activity (calculator – supporting conclusions)
 - ball drop lab (calculator experiment)
 - quizzes and exam

Course Plan (continued):

Unit 3 – Differentiation (2 weeks)

- Differentiation Rules
 - derivatives of basic elementary functions
 - sum, difference, product, quotient, and chain rules
- Implicit Differentiation
- Logarithmic Differentiation
 - derivative of inverse functions
- Assessments
 - bouncing wagon activity (graphing software problem solving)
 - quizzes and exam

Unit 4 – Applications of Differentiation (4 weeks)

- Linear Motion
 - position, velocity, acceleration
 - speed, distance traveled, displacement
- Linear Approximations
 - differentials
 - l'Hospital's rule
- Related Rates
- Mean Value Theorem
- Graph Behavior
 - absolute and relative extrema
 - increasing and decreasing behavior
 - concavity and inflection points
- Optimization
- Antiderivatives
 - slope fields
 - graph behavior
- Assessments
 - graph behavior activity (graphing software problem solving)
 - related rates lab (calculator experiment)
 - quizzes and exam

Course Plan (continued):

Unit 5 – Integrals (2 weeks)

- Concept of a Definite Integral
 - relationship between area and definite integral
 - Riemann sums
- Integral Functions
 - concept of accumulation
- Fundamental Theorem of Calculus
 - evaluation of a definite integral using antiderivative
 - total change in a quantity
 - differentiation of an integral function
- Integral Approximation
 - rectangle methods
 - trapezoid method
- Assessments
 - area activity (calculator exploration)
 - quizzes and exam

Unit 6 – Integration (3 weeks)

- Substitution
 - change of variables for indefinite integrals
 - change of variables for definite integrals
- Integration by Parts
 - tabular integration
- Integration of Rational Functions
 - polynomial division
 - partial fraction decomposition
- Improper Integrals
- Assessments
 - integration activity (calculator problem solving/ supporting conclusions)
 - quizzes and exam

Unit 7 – Applications of Integration (2 weeks)

- Average Value
- Area Between Two Curves
- Cross-Sectional Volume
- Assessments
 - volume activity (calculator experiment)
 - quizzes and exam

Course Plan (continued):

Unit 8 – Differential Equations (2 weeks)

- Slope Fields
- Euler's Method
- Separable Differential Equations
 - growth and decay applications
- Logistic Growth
- Assessments
 - Newton's Law of Cooling lab (calculator experiment/ interpretation of results)
 - Euler's method activity (spreadsheet software problem solving)
 - logistic growth activity (calculator exploration)
 - quizzes and exam

Unit 9 – Infinite Series (3 weeks)

- Basic Series
 - geometric series
 - p -series
 - telescoping series
- Convergence Tests
 - divergence test
 - integral test
 - direct comparison test
 - limit comparison test
 - alternating series test
 - test for absolute convergence
 - ratio test
- Error Bound for Convergent Alternating Series
- Assessments
 - infinite series activities (calculator exploration/problem solving)
 - quizzes and exam

Course Plan (continued):

Unit 10 – Taylor Polynomials and Power Series (3 weeks)

- Taylor Polynomials
- Power Series
 - radius and interval of convergence
- Taylor and Maclaurin Series
 - series for $\sin x$, $\cos x$, e^x , and $1/(1 - x)$
- Creating Power Series
 - operations involving power series
 - compositions involving power series
 - differentiation of power series
 - integration of power series
- Error Analysis
 - Lagrange error bound
- Assessments
 - Taylor polynomial activity (calculator exploration/ supporting conclusions)
 - quizzes and exam

Unit 11 – Parametric, Polar, and Vector Functions (3 weeks)

- Parametrically-Defined Curves
 - slope and rates of change
 - area
 - arc length
- Polar Functions
 - slope and rates of change
 - area
- Vector Functions
- Planar Motion
- Assessments
 - motion activity (calculator problem solving)
 - quizzes and exam

Additional Assessments:

In addition to the various activities, labs, and regular exams, this course also requires a midterm exam, one final exam, and one term project. The midterm assesses the curriculum topics through differentiation and introductory integration. The cumulative final exam covers all topics for the semester.

The term project is a collaborative activity that explores an open-ended, real-life problem involving concepts presented in this course. The project attempts to draw connections not only in calculus, but other subject areas as well.

With exception of the midterm and final exams (which are of a multiple-choice format), all activities and assessments require students to communicate the associated calculus concepts presented in written form. This includes not only providing clear computational processes, but also explaining and justifying solutions through quality sentences.