Course Title: AP CALCULUS (BC)
Board Approval Date:
Credit / Hours: 1
Reviewed Annually

Course Description:

AP Calculus BC is roughly equivalent to both first and second semester college calculus courses and extends the content learned in AB to different types of equations and introduces the topic of sequences and series. This course covers topics in differential and integral calculus, including concepts and skills of limits, derivatives, definite integrals, the Fundamental Theorem of Calculus, and series. You will learn how to approach calculus concepts and problems when they are represented graphically, numerically, analytically, and verbally, and to make connections amongst these representations.
You will also learn how to use technology to help solve problems, experiment, interpret results, and support conclusions.
*Students will need a TI-89 graphing calculator for this course.

Learning Activities / Modes of Assessment:

Large Group instruction	Tests and Quizzes
Checklists/Teacher Observation.	Small Group Work
Projects with Rubrics	Computer simulations
Homework Assignments	

Instructional Resources:

*AP*Edition Calculus of a Single Variable*(Brooks/Cole, Cengage Learning 2010)

Course Pacing Guide

Course: AP Calculus (BC)

Course Unit (Topic) (Days/Periods)	**Length of Instruction**
1. Unit #1 Review of AP Calculus (AB)	10 days
2. Unit #2 Differential Equations	15 days
3. Unit #3 Applications of Integration	12 days
4. Unit #4 Advanced Integration Techniques	10 days
5. Unit #5 Indeterminate Forms, Improper Integrals	6 days
6. Unit #6 Sequences and Series.	25 days
7. Unit #7 Taylor Polynomials and Power Series	20 days
8. Unit #8 Parametric Equations	15 days
9. Unit #9 Polar Curves	15 days
Total Days	128 days

AP Calculus (BC) KUD **Unit 1: Review of AP Calculus (AB)**
Text: Calculus of a Single Variable. Larson, Edwards. 9th edition. **Time Frame: 10 days**

Know:

Students will be expected to maintain their knowledge of the topics presented to them throughout AP Calculus (AB).

Understand:

Derivatives can be used to calculate instantaneous rates of change.

Integrals can be used to calculate accumulations over time.

Do:

Students were taught how to find derivatives and integrals throughout AP Calculus (AB). Students will be expected to maintain their skills in calculating derivatives and integrals and use these skills to solve rigorous problems of the type presented on the Advanced Placement Calculus Exam.

BC Calculus Unit 1: Review of AP Calculus (AB) **Length of instruction: 10 Days**

Unit Essential Question:

What are the key concepts students need to know from AB Calculus?

Concept:	***Concept:***	***Concept:***	***Concept:***
Limits of Functions	Derivatives and their applications	Integrals and their applications	
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
Refer to AB Calculus maps	Refer to AB Calculus maps	Refer to AB Calculus maps	
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Refer to AB Calculus maps	Refer to AB Calculus maps	Refer to AB Calculus maps	

AP Calculus (BC) KUD **Unit 2: Differential Equations**
Text: 6.1, 6.2, 6.3 **Time Frame: 15 days**
AP Calculus Standards: APC.8, APC.11, APC.14 (See attached document)

Know:	**Understand:**	**Do:**
Differential Equation General Solution Particular Solution Initial Conditions Slope Field Euler's Method Separation of Variables Proportionality Constant Exponential Growth Exponential Decay Newton's Law of Cooling Separable Differential Equation Logistic Differential Equation Carrying Capacity	Real world phenomena can be modeled by using differential equations. Being able to manipulate, visualize, and solve these equations can help us to better understand these phenomena.	**Students will be able to:** Use initial conditions to find particular solutions to differential equations Draw slope fields to visualize solutions to differential equations Use Euler's Method to approximate solutions to differential equations Use separation of variables to solve simple differential equations Use exponential functions to model growth and decay in applied problems Recognize when separation of variables is a viable solution technique Solve logistic differential equations

BC Calculus Unit 2: Differential Equations **Length of Instruction: 15 days**

Unit Essential Question:

How do we visualize, solve, and approximate the solutions to differential equations?

Concept:	***Concept:***	***Concept:***	***Concept:***
Visualizing the solution to a differential equation using a slope field	Solving separable differential equations	Approximating the solution to a differential equation	
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
How can a slope field be used to visualize the solution to a differential equation? What is the technique used to draw the particular solution to a differential equation on a slope field?	How is separation of variables used to solve a differential equation? What are the general and particular solutions to a differential equation?	How is Euler's Method used to approximate the solution to a differential equation?	
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Differential equation, slope field	General solution, particular solution, initial conditions, separation of variables, proportionality constant, exponential growth/decay, Newton's Law of Cooling, separable differential equation, logistic differential equation, carrying capacity	Euler's Method	

AP Calculus (BC) KUD **Unit 3: Applications of Integration**
Text: 7.1, 7.2, 7.3, 7.4 **Time Frame: 12 days**
AP Calculus Standards: APC.13, APC.15 (See attached document)

Know:

Area between two curves

Representative Rectangle

Solid of Revolution

Axis of Revolution

Disk Method

Representative Disk

Washer Method

Representative Washer

Solid with a known cross section

Shell Method

Representative Shell

Arc Length

Understand:

The definite integral can be used to calculate arc lengths, areas, and volumes for irregular curves, shapes, and solids.

Do:

Students will be able to:

Describe integration as an accumulation process

Calculate the area between two curves using both vertical and horizontal representative rectangles

Compute the volume of a solid of revolution using the disk, washer, and shell methods

Compute the volume of a solid with a known cross section

Decide when it is best to use the disk/washer method as opposed to the shell method

Calculate the length of a given curve using integration

BC Calculus Unit 3: Applications of Integration **Length of instruction: 12 Days**

Unit Essential Question:

What are the different situations to which an integral can be applied?

Concept:	***Concept:***	***Concept:***	***Concept:***
Calculating the area of an irregular shape	Calculating the volume of a solid of revolution	Calculating the volume of a solid with a known cross-section	Calculating the length of a curve
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
How can an integral be used to calculate the area of an irregular shape?	How can an integral be used to calculate the volume of a solid of revolution?	How can an integral be used to calculate the volume of a solid with a known cross-section?	How can an integral be used to calculate the length of a piece of a given curve?
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Area between two curves, representative rectangle	Solid of revolution, axis of revolution, disk method, representative disk, washer method, representative washer, shell method, representative shell	Solid with a known cross-section	Arc length

AP Calculus (BC) KUD **Unit 4: Advanced Integration Techniques**
Text: 8.1, 8.2, 8.5 **Time Frame: 10 days**
AP Calculus Standards: APC.13, APC.15 (See attached document)

Know:

Basic integration rules

U-Substitution

Expansion

Separating the numerator

Completing the square

Synthetic Division

Long Division

Addition of zero

Trigonometric identities

Pythagorean Conjugate

Integration by Parts

Tabular Method

Partial fraction decomposition

Method of Partial Fractions

Distinct Linear Factors

Understand:

Many indefinite and definite integrals require the use of advanced integration techniques. Being able to use these techniques expands the range of problems for which students can find a solution when given an accumulation challenge.

Do:

Students will be able to:

Compute integrals using the techniques taught to them throughout AP Calculus (AB)

Calculate an antiderivative using the technique of integration by parts

Calculate an antiderivative using the tabular method

Determine when an integral may be done more easily using the tabular method

Understand the concept of partial fraction decomposition

Use the method of partial fractions to compute integrals with distinct linear factors

BC Calculus Unit 4: Advanced Integration Techniques **Length of instruction: 10 Days**

Unit Essential Question:

What are the advanced techniques of integration that students will be required to know for the BC Calculus exam?

Concept:	***Concept:***	***Concept:***	***Concept:***
Basic Integration Concepts	Integration by Parts	Integration using Partial Fractions	
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
What are the basic concepts that can be used to calculate common antiderivatives?	When can integration by parts be used to calculate an antiderivative?	When can partial fractions be used to calculate an antiderivative?	
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Basic integration rules, u-substitution, expansion, separating the numerator, completing the square, synthetic division, long division, addition of zero, trigonometric identities, Pythagorean conjugate	Integration by parts, tabular method	Partial fraction decomposition, method of partial fractions, distinct linear factors	

AP Calculus (BC) KUD **Unit 5: Indeterminate Forms, Improper Integrals**
Text: 8.7, 8.8 **Time Frame: 6 days**
AP Calculus Standards: APC.2, APC.8, APC.9 (See attached document)

Know:

Indeterminate Forms

L'Hopital's Rule

Extended Mean Value Theorem

Improper Integral

Infinite Discontinuity

Convergent

Divergent

Gabriel's Horn

Understand:

There are several indeterminate forms which will cause a limit to be difficult to compute. These limits will arise when attempting to calculate an improper integral. These types of integrals must be approached using the techniques learned in this unit.

Do:

Students will be able to:

Recognize limits that produce indeterminate forms

Apply L'Hopital's Rule (sometimes multiple times) to evaluate a limit

Manipulate certain types of limits to get them in a form for which L'Hopital's Rule will succeed

Evaluate an improper integral that has an infinite limit of integration

Evaluate an improper integral that has an infinite discontinuity

Calculate the volume and surface area of Gabriel's Horn

Recognize that improper integrals can often lead to non-intuitive results

BC Calculus Unit 5: Indeterminate Forms and Improper Integrals **Length of instruction: 6 Days**

Unit Essential Question:

What are the various indeterminate forms, and how can an improper integral be calculated?

Concept:	***Concept:***	***Concept:***	***Concept:***
Calculating a limit when an indeterminate form is encountered	Evaluating an improper integral with an infinite limit of integration	Evaluating an improper integral with an interior discontinuity	
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
What are the various indeterminate forms? How can a limit be found when an indeterminate form is encountered?	What technique is used to calculate an improper integral with an infinite limit of integration?	What technique is used to calculate an improper integral with an interior discontinuity?	
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Indeterminate forms, L'Hopital's Rule, Extended Mean Value Theorem	Improper integral, infinite discontinuity, convergent, divergent, Gabriel's Horn	Improper integral, interior discontinuity, convergent, divergent	

AP Calculus (BC) KUD **Unit 6: Sequences and Series**
Text: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6 **Time Frame: 25 days**
AP Calculus Standards: APC.16 (See attached document)

Know:

Infinite sequence

Nth term

Convergent sequence

Divergent sequence

Factorial

Absolute Value Theorem

Monotonic sequence

Bounded sequence

Infinite series

Partial sum

Convergent series

Divergent series

Sum of a series

Telescoping series

Geometric series

Nth term test for divergence

Fractal

Integral test

p-series test

Harmonic series

Direct Comparison test

Limit Comparison test

Alternating Series test

Alternating Series remainder

Absolute convergence

Conditional convergence

Ratio/Root tests

Understand:

Calculus is the study of the infinite and the infinitesimal. Learning how to work with infinite sequences and series is at the heart of the discipline. Being able to calculate the convergence or divergence of a sequence or a series allows a student to further explore the complexities of Calculus.

Do:

Students will be able to:

Determine whether a sequence converges or diverges

Write a formula for the nth term of a sequence

Use properties of monotonic and bounded sequences

Understand what it means for an infinite series to be convergent

Calculate the sums of telescoping and geometric series

Use the nth term test

Use the integral test and p-series test to determine convergence/divergence

Use the direct and limit comparison tests to determine convergence/divergence

Use the alternating series test to determine convergence/divergence

Use the alternating series remainder to approximate the sum of a series

Classify a series as absolutely/conditionally convergent

Use the ratio and root tests to determine convergence/divergence

BC Calculus Unit 6: Sequences and Series **Length of instruction: 25 Days**

Unit Essential Question:

How can we determine whether a sequence or series converges or diverges?

Concept:	***Concept:***	***Concept:***	***Concept:***
How can the convergence/divergence of a sequence be determined?	How can we calculate or approximate the sums of various types of series?	How can convergence/divergence of a series be determined?	What is the difference between absolute and conditional convergence?
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
How can the nth term expression be used to determine convergence/divergence of a sequence? What does it mean when a sequence is monotonic and bounded?	What is a telescoping series, and how can we calculate its value? What is a geometric series, and how can we calculate its value? How can the alternating series remainder be used to approximate the sum of a series?	What are the various tests that can be used to determine convergence/divergence of a series?	What does it mean when a series is absolutely convergent? What does it mean when a series is conditionally convergent?
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Infinite sequence, nth term, convergent sequence, divergent sequence, factorial, absolute value theorem, monotonic sequence, bounded sequence	Infinite series, partial sum, convergent series, divergent series, sum of a series, telescoping series, geometric series, fractal, alternating series remainder	Nth term test for divergence, integral test, p-series test, harmonic series, direct comparison test, limit comparison test, alternating series test, ratio/root tests	Absolute convergence, conditional convergence

AP Calculus (BC) KUD **Unit 7: Taylor Polynomials, Power Series**
Text: 9.7, 9.8, 9.9, 9.10 **Time Frame: 20 days**
AP Calculus Standards: APC.9, APC.13, APC.17 (See attached document)

Know:

Polynomial approximation of a function

Centered at c

Taylor polynomial

Maclaurin polynomial

Remainder of a Taylor/Maclaurin polynomial

Lagrange form of the remainder

Power series

Radius of convergence

Interval of convergence

Differentiating the power series

Integrating the power series

Geometric power series

Taylor series

Maclaurin series

Power series formulas for elementary functions

Understand:

Functions can often be approximated by using simpler polynomial functions. At times, these polynomials can be extended to the infinite, creating an exact model of the given function. Modern calculators and computers extensively use these ideas. Because of this, any student who wishes to move further into a variety of high tech fields should have a solid knowledge of the material in this unit.

Do:

Students will be able to:

Find polynomial approximations of elementary functions

Find Taylor and Maclaurin polynomial approximations of elementary functions

Use the remainder of the Taylor polynomial to determine the accuracy of an approximation

Understand the definition of a power series

Find the radius and interval of convergence of a power series

Determine the endpoint convergence of a power series

Differentiate and integrate a power series

Find a geometric power series that represents a function

Construct a power series using series operations

Find an infinite Taylor/Maclaurin series for a given function

Use a basic list of Taylor/Maclaurin series to find other Taylor/Maclaurin series

BC Calculus Unit 7: Taylor Polynomials and Power Series **Length of instruction: 20 Days**

Unit Essential Question:

How can Taylor Polynomials and Power Series be used to model various types of functions?

Concept:	***Concept:***	***Concept:***	***Concept:***
Taylor polynomials	Determining the accuracy of a Taylor polynomial	Power series	Taylor series
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
How can a Taylor polynomial be developed for a given function?	How can the remainder of a Taylor polynomial be calculated in order to determine its accuracy?	How can a power series be developed for certain functions?	How can the concept of a Taylor polynomial be extended to a Taylor series?
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Polynomial approximation of a function, centered at c, Taylor polynomial, Maclaurin polynomial	Remainder of a Taylor/Maclaurin polynomial, Lagrange form of the remainder	Power series, radius of convergence, interval of convergence, differentiating the power series, integrating the power series, geometric power series	Taylor series, Maclaurin series, power series formulas for elementary functions

AP Calculus (BC) KUD **Unit 8: Parametric Equations**
Text: 10.2, 10.3 **Time Frame: 15 days**
AP Calculus Standards: APC.8, APC.9, APC.15 (See attached document)

Know:

Parameter

Parametric equation

Plane curve

Orientation of the curve

Eliminating the parameter

Brachistochrone

Parametric form of the derivative

Parametric form of higher-order derivatives

Arc Length in parametric form

Understand:

It is possible to use three variables to represent a curve in the coordinate plane. These are called parametric curves, and allow us to expand the types of graphs we can create and use. Students will learn how to work with the derivatives of these functions in much the same way they did for elementary functions.

Do:

Students will be able to:

Sketch the graph of a set of parametric equations

Eliminate the parameter in a set of parametric equations

Find a set of parametric equations to represent a given curve

Understand the Brachistochrone problem, which is a classic Calculus challenge

Calculate the slope of a tangent line to a given set of parametric equations

Calculate higher-order derivatives for a set of parametric equations

Calculate the length of a parametric curve on a given domain

BC Calculus Unit 8: Parametric Equations **Length of instruction: 15 Days**

Unit Essential Question:

What are parametric equations, and how can we use them in calculus?

Concept:	***Concept:***	***Concept:***	***Concept:***
Graphing parametric equations	Eliminating the parameter	The calculus of parametric equations	Vector Valued Functions
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
How can a parametric equation be graphed by hand? How can a parametric equation be graphed using technology?	How can we convert a parametric equation to its rectangular form?	How can we calculate the first and second derivatives of parametric equations? How can we calculate the length of the arc of a parametric curve?	How can we find the velocity and acceleration vectors? How can we calculate the speed of an object moving along a parametric path? How can we calculate the total distance traveled by an object moving along a parametric path?
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Parameter, parametric equation, plane curve, orientation of the curve, brachistochrone	Eliminating the parameter	Parametric form of the derivative, parametric form of higher-order derivatives, arc length in parametric form	Velocity vector, acceleration vector, speed in parametric form, total distance traveled in parametric form

AP Calculus (BC) KUD **Unit 9: Polar Curves**
Text: 10.4, 10.5 **Time Frame: 15 days**
AP Calculus Standards: APC.8, APC.9, APC.15 (See attached document)

Know:

Polar coordinate system

Polar-to-rectangular conversion

Rectangular-to-polar conversion

Slope in polar form

Limacon

Rose

Lemniscate

Area in polar coordinates

Area of a region between two polar curves

Understand:

By using a new coordinate system, students will be able to graph, study, and work with entirely new classes of functions. Polar coordinates allow us to solve old problems in new ways and work with functions that were not previously possible. We can extend our use of the derivative and integral to polar coordinates to study those Calculus concepts.

Do:

Students will be able to:

Understand the polar coordinate system

Convert from polar to rectangular equations

Convert from rectangular to polar equations

Sketch the graph of a given polar curve

Identify several types of special polar curves

Graph a variety of limacons, roses, and lemniscates

Calculate the slope of a tangent line to a polar curve

Find horizontal and vertical tangent lines to polar curves

Calculate the area of a region bounded by a polar curve

Find the points of intersection of two polar curves

Calculate the area between two polar curves

BC Calculus Unit 9: Polar Curves **Length of instruction: 15 Days**

Unit Essential Question:

What are the calculus concepts we can apply to polar curves?

Concept:	***Concept:***	***Concept:***	***Concept:***
Graphing polar curves	Converting from polar to rectangular and back	Applying calculus to polar curves	
Lesson Essential Question/s:	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***	***Lesson Essential Question/s:***
How can polar curves be graphed by hand? How can polar curves be graphed using technology?	How can one convert from polar form to rectangular form? How can one convert from rectangular form to polar form?	How can one calculate the derivative of a polar curve? How can the area of a region between two polar curves be calculated?	
Vocabulary:	***Vocabulary:***	***Vocabulary:***	***Vocabulary:***
Polar coordinate system, limacon, rose, lemniscate	Polar-to-rectangular conversion, rectangular-to-polar conversion	Slope in polar form, area in polar coordinates, area of a region between two polar curves	