Mathematics Department

AP BC Calculus

Developed By: Mark Picard
Effective Date: 09/01/2026

Scope and Sequence

Unit	Topic of Study	Duration (Weeks Taught)
1	Pre-requisites, Limits and Rates of Change	1 weeks
2	The Derivative	2 weeks
3	Curve Sketching and Applications of the Derivative	1.5 weeks
4	Integration Basics	2 weeks
5	Integration Techniques and Differential Equations	4.5 weeks
6	Applications of Integration	3 weeks
7	Parametric Equations, Polar Equations and Vectors	5 weeks
8	Sequences and Series	6 weeks

Unit 1
Pre-Requisites, Limits and Rates of Change
Summary and Rationale
Limits introduce the subtle distinction between evaluating a function at a point and considering what value the function is approaching, if any, as x approaches a point. This distinction allows us to extend understanding of asymptotes and holes in graphs with formal definitions of continuity. Consider reviewing rational functions when introducing limits, rather than beginning the year with a full review of precalculus topics. Limits are the foundation for differentiation (Unit 2), integration (Unit 6), and infinite series (Unit 10)

bc only. They are the basis for important definitions and for theorems that are used to solve realistic problems involving change and to justify conclusions.

Recommended Pacing

3 Weeks

Standards

CHA-1, LIM-1, LIM-2, FUN-1

Instructional Focus

Unit Essential Questions:
- What is a limit?
- What does a limit mean both algebraically, numerically and graphically?
- What is an average rate of change versus an instantaneous rate of change?

Unit Enduring Understandings:
- How to take a limit at a point or at infinity
- Identify types of discontinuity
- Calculate an instantaneous rate of change using a limit.

Evidence of Learning (Assessments)

Assign the Progress Checks from AP Course and Exam Description Resource for each unit.
Each Personal Progress Check contains formative multiple-choice and free-response questions.
The feedback from the Personal Progress Checks shows students the areas where they need to focus.

Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~22–23 CLASS PERIODS (AB) ~13–14 CLASS PERIODS (BC)
CHA-1	**1.1 Introducing Calculus: Can Change Occur at an Instant?**	2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.	
LIM-1	**1.2 Defining Limits and Using Limit Notation**	2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.	
	1.3 Estimating Limit Values from Graphs	2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.	
	1.4 Estimating Limit Values from Tables	2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.	
	1.5 Determining Limits Using Algebraic Properties of Limits	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	1.6 Determining Limits Using Algebraic Manipulation	1.C Identify an appropriate mathematical rule or procedure based on the classification of a given expression (e.g., Use the chain rule to find the derivative of a composite function).	
	1.7 Selecting Procedures for Determining Limits	1.C Identify an appropriate mathematical rule or procedure based on the classification of a given expression (e.g., Use the chain rule to find the derivative of a composite function).	
	1.8 Determining Limits Using the Squeeze Theorem	3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.	
	1.9 Connecting Multiple Representations of Limits	2.C Identify a re-expression of mathematical information presented in a given representation.	

Enduring Understanding	Topic	Suggested Skills	Class Periods ~22–23 CLASS PERIODS (AB) ~13–14 CLASS PERIODS (BC)
LIM-2	**1.10 Exploring Types of Discontinuities**	3.B Identify an appropriate mathematical definition, theorem, or test to apply.	
	1.11 Defining Continuity at a Point	3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.	
	1.12 Confirming Continuity over an Interval	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	1.13 Removing Discontinuities	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	1.14 Connecting Infinite Limits and Vertical Asymptotes	3.D Apply an appropriate mathematical definition, theorem, or test.	
	1.15 Connecting Limits at Infinity and Horizontal Asymptotes	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	
FUN-1	**1.16 Working with the Intermediate Value Theorem (IVT)**	3.E Provide reasons or rationales for solutions or conclusions.	
	Go to **AP Classroom** to assign the **Progress Check** for Unit 1. Review the results in class to identify and address any student misunderstandings.		

Suggested Resources/Technology Tools

College Board AP Website

Modifications

Special Education-

Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.

- Allow additional time for skill mastery.
- Provide small group/ individualized instruction.
- Allow use of assistive technology.
- Anticipate needs; pre-teach if needed.
- Have student repeat directions to check for understanding.
- Highlight text/ visual presentation.
- Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

● Provide additional wait time for student responses to questions
● Provide simplification of sentence structure and repetition of questions/sentences exactly as stated before trying to rephrase.
● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading

Gifted and Talented-

● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.

● Provide additional time for in-class assignments and assessments
● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
● Modify readings and primary source documents

At Risk-

● Provide small group instruction for identified areas for growth
● Allow for alternate pathways for completion of assignments.
● Provide additional wait time for student responses to questions
● Pair oral instruction with visuals
● Utilize manipulatives

For a full list of Accommodations and Modifications, please click here.

Career Readiness, Life Literacies, and Key Skills Practices (June 2020)

Please select all standards that apply to this unit of study:

- ☐ Act as a responsible and contributing citizen and employee.
- ☑ Apply appropriate academic and technical skills.
- ☐ Attend to personal health and financial well being.
- ☑ Communicate clearly and effectively and with reason.
- ☑ Consider the environmental, social and economics impacts of decisions.
- ☑ Demonstrate creativity and innovation.
- ☐ Employ valid and reliable research strategies.
- ☑ Utilize critical thinking to make sense of problems and persevere in solving them.
- ☐ Model integrity, ethical leadership, and effective management.
- ☐ Plan education and career paths aligned to personal goals.
- ☑ Use technology to enhance productivity.
- ☐ Work productively in teams while using cultural global competence.

Unit 2

The Derivative

Summary and Rationale

Derivatives allow us to determine instantaneous rates of change. To develop understanding of how the definition of the derivative applies limits to average rates of change, create opportunities for students to explore average rates of change over increasingly small intervals. Graphing calculator explorations of how various operations affect slopes of tangent lines help students to make sense of basic rules and properties of differentiation. Encourage students to apply the order of operations as they select differentiation rules. Developing differentiation skills will allow students to model realistic instantaneous rates of change in future units

Recommended Pacing

6 Weeks

Standards

CHA-3, LIM-4,

Instructional Focus

Unit Essential Questions:

- What does an instantaneous rate of change mean and how does it relate to the derivative?
- How do we compute a derivative at a point using a limit?
- How do we compute a derivative or develop an expression for it?

Unit Enduring Understandings:

- Use the difference quotient to find a derivative as well power, product, quotient and chain rules
- Create tangent and normal lines to functions.
- Find the derivative of inverse functions.

Evidence of Learning (Assessments)

Assign the Progress Checks from AP Course and Exam Description Resource for each unit.
Each Personal Progress Check contains formative multiple-choice and free-response questions.
The feedback from the Personal Progress Checks shows students the areas where they need to focus.

Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~13–14 CLASS PERIODS (AB) ~9–10 CLASS PERIODS (BC)
CHA-2	**2.1 Defining Average and Instantaneous Rates of Change at a Point**	2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.	
CHA-2	**2.2 Defining the Derivative of a Function and Using Derivative Notation**	1.D Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems. 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using $f'(x)$, y', and $\frac{dy}{dx}$).	
CHA-2	**2.3 Estimating Derivatives of a Function at a Point**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
FUN-2	**2.4 Connecting Differentiability and Continuity: Determining When Derivatives Do and Do Not Exist**	3.E Provide reasons or rationales for solutions and conclusions.	
FUN-3	**2.5 Applying the Power Rule**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
FUN-3	**2.6 Derivative Rules: Constant, Sum, Difference, and Constant Multiple**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
FUN-3 LIM-3	**2.7 Derivatives of $\cos x$, $\sin x$, e^x, and $\ln x$**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	

Enduring Understanding	Topic	Suggested Skills	Class Periods ~13–14 CLASS PERIODS (AB) ~9–10 CLASS PERIODS (BC)
FUN-3	**2.8 The Product Rule**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	2.9 The Quotient Rule	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	2.10 Finding the Derivatives of Tangent, Cotangent, Secant, and/or Cosecant Functions	1.D Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems.	
	Go to **AP Classroom** to assign the **Progress Check** for Unit 2. Review the results in class to identify and address any student misunderstandings.		

Suggested Resources/Technology Tools

College Board AP Website

Modifications

Special Education-

Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.

- Allow additional time for skill mastery.
- Provide small group/ individualized instruction.
- Allow use of assistive technology.
- Anticipate needs; pre-teach if needed.
- Have student repeat directions to check for understanding.
- Highlight text/ visual presentation.
- Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

- Provide additional wait time for student responses to questions
- Provide simplification of sentence structure and repetition of questions/sentences exactly as stated before trying to rephrase.
- Speak clearly, using a normal tone and rate of speed, or slightly slower.
- Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading

Gifted and Talented-

- Advance, accelerate, or compact content
- Support abstract and advanced higher-level thinking through differentiated questioning
- Allowance for adapting of content for individual student interests
- Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.
- Provide additional time for in-class assignments and assessments
- Allow for computer with voice output, spelling and grammar checker
- Offer individual help throughout the lesson
- Modify readings and primary source documents

At Risk-
- Provide small group instruction for identified areas for growth
- Allow for alternate pathways for completion of assignments.
- Provide additional wait time for student responses to questions
- Pair oral instruction with visuals
- Utilize manipulatives

For a full list of Accommodations and Modifications, please click here.

Career Readiness, Life Literacies, and Key Skills Practices (June 2020)

Please select all standards that apply to this unit of study:

- ☐ Act as a responsible and contributing citizen and employee.
- ☑ Apply appropriate academic and technical skills.
- ☐ Attend to personal health and financial well being.
- ☑ Communicate clearly and effectively and with reason.
- ☑ Consider the environmental, social and economics impacts of decisions.
- ☑ Demonstrate creativity and innovation.
- ☐ Employ valid and reliable research strategies.
- ☑ Utilize critical thinking to make sense of problems and persevere in solving them.
- ☐ Model integrity, ethical leadership, and effective management.
- ☐ Plan education and career paths aligned to personal goals.
- ☑ Use technology to enhance productivity.
- ☐ Work productively in teams while using cultural global competence.

Unit 3

Curve Sketching and Applications of the Derivative

Summary and Rationale

Unit 3 begins by developing understanding of average and instantaneous rates of change in problems involving motion. The unit then identifies differentiation as a common underlying structure on which to build understanding of change in a variety of contexts. Students' understanding of units of measure often reinforces their understanding of contextual applications of differentiation. In problems involving related rates, identifying the independent variable common to related functions may help students to correctly apply the chain rule. When applying differentiation to determine limits of certain

Curve sketching is fleshed out as students will learn to present justifications for their conclusions about the behavior of functions over certain intervals or the locations of extreme values or points of inflection and concavity.

Recommended Pacing

5.5 Weeks

Standards

CHA-3, LIM-4, FUN-1, FUN-4

Instructional Focus

Unit Essential Questions:

- How does the derivative and second derivative govern the appearance of a function?
- What is the relationship between position, velocity and acceleration?
- How can we optimize a function?

Unit Enduring Understandings:

- Mark predictions of a particle's motion.
- Use derivatives and differentials to approximate small changes in a function or relate rates of one function to another.
- Sketch functions by their features such as minimums, maximums and inflection points.
- Apply the mean value theorem for derivatives or show that it holds for a differentiable function.

Evidence of Learning (Assessments)

Assign the Progress Checks from AP Course and Exam Description Resource for each unit.
Each Personal Progress Check contains formative multiple-choice and free-response questions.
The feedback from the Personal Progress Checks shows students the areas where they need to focus.

Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~10–11 CLASS PERIODS (AB) ~6–7 CLASS PERIODS (BC)
CHA-3	**4.1 Interpreting the Meaning of the Derivative in Context**	1.D Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems.	
	4.2 Straight-Line Motion: Connecting Position, Velocity, and Acceleration	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	4.3 Rates of Change in Applied Contexts Other Than Motion	2.A Identify common underlying structures in problems involving different contextual situations.	
	4.4 Introduction to Related Rates	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	4.5 Solving Related Rates Problems	3.F Explain the meaning of mathematical solutions in context.	
	4.6 Approximating Values of a Function Using Local Linearity and Linearization	1.F Explain how an approximated value relates to the actual value.	
LIM-4	**4.7 Using L'Hospital's Rule for Determining Limits of Indeterminate Forms**	3.D Apply an appropriate mathematical definition, theorem, or test.	

Go to **AP Classroom** to assign the **Progress Check** for Unit 4.
Review the results in class to identify and address any student misunderstandings.

Enduring Understanding	Topic	Suggested Skills	Class Periods ~15–16 CLASS PERIODS (AB) ~10–11 CLASS PERIODS (BC)
FUN-1	**5.1 Using the Mean Value Theorem**	3.E Provide reasons or rationales for solutions and conclusions.	
FUN-1	**5.2 Extreme Value Theorem, Global Versus Local Extrema, and Critical Points**	3.E Provide reasons or rationales for solutions and conclusions.	
FUN-4	**5.3 Determining Intervals on Which a Function is Increasing or Decreasing**	2.E Describe the relationships among different representations of functions and their derivatives.	
FUN-4	**5.4 Using the First Derivative Test to Determine Relative (Local) Extrema**	3.D Apply an appropriate mathematical definition, theorem, or test.	
FUN-4	**5.5 Using the Candidates Test to Determine Absolute (Global) Extrema**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
FUN-4	**5.6 Determining Concavity of Functions over Their Domains**	2.E Describe the relationships among different representations of functions and their derivatives.	
FUN-4	**5.7 Using the Second Derivative Test to Determine Extrema**	3.D Apply an appropriate mathematical definition, theorem, or test.	
FUN-4	**5.8 Sketching Graphs of Functions and Their Derivatives**	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	
FUN-4	**5.9 Connecting a Function, Its First Derivative, and Its Second Derivative**	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	
FUN-4	**5.10 Introduction to Optimization Problems**	2.A Identify common underlying structures in problems involving different contextual situations.	
FUN-4	**5.11 Solving Optimization Problems**	3.F Explain the meaning of mathematical solutions in context.	
FUN-4	**5.12 Exploring Behaviors of Implicit Relations**	1.E Apply appropriate mathematical rules or procedures, with and without technology. 3.E Provide reasons or rationales for solutions and conclusions.	
	Go to **AP Classroom** to assign the **Progress Check** for Unit 5. Review the results in class to identify and address any student misunderstandings.		

Suggested Resources/Technology Tools

College Board AP Website

Modifications

Special Education-

Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.

- Allow additional time for skill mastery.
- Provide small group/ individualized instruction.
- Allow use of assistive technology.
- Anticipate needs; pre-teach if needed.
- Have student repeat directions to check for understanding.
- Highlight text/ visual presentation.
- Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

- Provide additional wait time for student responses to questions
- Provide simplification of sentence structure and repetition of questions/sentences exactly as stated before trying to rephrase.
- Speak clearly, using a normal tone and rate of speed, or slightly slower.
- Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading

Gifted and Talented-

- Advance, accelerate, or compact content
- Support abstract and advanced higher-level thinking through differentiated questioning
- Allowance for adapting of content for individual student interests
- Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.

- Provide additional time for in-class assignments and assessments
- Allow for computer with voice output, spelling and grammar checker
- Offer individual help throughout the lesson
- Modify readings and primary source documents

At Risk-

- Provide small group instruction for identified areas for growth
- Allow for alternate pathways for completion of assignments.
- Provide additional wait time for student responses to questions
- Pair oral instruction with visuals
- Utilize manipulatives

For a full list of Accommodations and Modifications, please click here.

Career Readiness, Life Literacies, and Key Skills Practices (June 2020)

Please select all standards that apply to this unit of study:

- ☐ Act as a responsible and contributing citizen and employee.
- ☑ Apply appropriate academic and technical skills.
- ☐ Attend to personal health and financial well being.
- ☑ Communicate clearly and effectively and with reason.
- ☑ Consider the environmental, social and economics impacts of decisions.

- [x] Demonstrate creativity and innovation.
- [ ] Employ valid and reliable research strategies.
- [x] Utilize critical thinking to make sense of problems and persevere in solving them.
- [ ] Model integrity, ethical leadership, and effective management.
- [ ] Plan education and career paths aligned to personal goals.
- [x] Use technology to enhance productivity.
- [ ] Work productively in teams while using cultural global competence.

Unit 4

Integration Basics

Summary and Rationale

This unit establishes the relationship between differentiation and integration using the Fundamental Theorem of Calculus. Students begin by exploring the contextual meaning of areas of certain regions bounded by rate functions. Integration determines accumulation of change over an interval, just as differentiation determines instantaneous rate of change at a point. Students need to understand that integration is a limiting case of a sum of products (areas) in the same way that differentiation is a limiting case of a quotient of differences (slopes). Future units will apply the idea of accumulation of change to a variety of realistic and geometric applications.

Recommended Pacing

4 Weeks

Standards

CHA-4, LIM-5, FUN-5, FUN-6, LIM-6

Instructional Focus

Unit Essential Questions:

- What information can be gained from the area bound by a curve?
- How can we get this area and how is it related to the anti-derivative?
- How can this area be approximated when exact values are not possible.
- How can we better approximate an integral by increasing the degree of our approximation from linear to quadratic?
- How do we know how good our approximation is?

Unit Enduring Understandings:

● Approximate the area bound by a curve using rectangular approximation methods
● Use anti-derivatives to calculate area and to find indefinite integrals.
● Apply the Trapezoidal rule and extend it to Simpson's rule to approximate an integral.
● Develop an error bound for Trapezoidal/Simpson's rule and calculate the required n-value to attain a prescribed error bound.
● Apply advanced techniques of integration including integration by parts, partial fraction decomposition, improper integrals, integral involving higher powers of trig functions

Evidence of Learning (Assessments)

Assign the Progress Checks from AP Course and Exam Description Resource for each unit.
Each Personal Progress Check contains formative multiple-choice and free-response questions.
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Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~18–20 CLASS PERIODS (AB) ~15–16 CLASS PERIODS (BC)
CHA-4	**6.1 Exploring Accumulations of Change**	4.B Use appropriate units of measure.	
LIM-5	**6.2 Approximating Areas with Riemann Sums**	1.F Explain how an approximated value relates to the actual value.	
	6.3 Riemann Sums, Summation Notation, and Definite Integral Notation	2.C Identify a re-expression of mathematical information presented in a given representation.	
FUN-5	**6.4 The Fundamental Theorem of Calculus and Accumulation Functions**	1.D Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems.	
	6.5 Interpreting the Behavior of Accumulation Functions Involving Area	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	
FUN-6	**6.6 Applying Properties of Definite Integrals**	3.D Apply an appropriate mathematical definition, theorem, or test.	
	6.7 The Fundamental Theorem of Calculus and Definite Integrals	3.D Apply an appropriate mathematical definition, theorem, or test.	
	6.8 Finding Antiderivatives and Indefinite Integrals: Basic Rules and Notation	4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using $f'(x)$, y', and $\frac{dy}{dx}$).	
	6.9 Integrating Using Substitution	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	6.10 Integrating Functions Using Long Division and Completing the Square	1.E Apply appropriate mathematical rules or procedures, with and without technology.	

Enduring Understanding	Topic	Suggested Skills	Class Periods ~18–20 CLASS PERIODS (AB) ~15–16 CLASS PERIODS (BC)
FUN-6	**6.11 Integrating Using Integration by Parts** **BC ONLY**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
FUN-6	**6.12 Integrating Using Linear Partial Fractions BC ONLY**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
LIM-6	**6.13 Evaluating Improper Integrals BC ONLY**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
FUN-6	**6.14 Selecting Techniques for Antidifferentiation**	1.C Identify an appropriate mathematical rule or procedure based on the classification of a given expression (e.g., Use the chain rule to find the derivative of a composite function).	

Suggested Resources/Technology Tools

College Board AP Website

Modifications

Special Education-

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- Allow use of assistive technology.
- Anticipate needs; pre-teach if needed.
- Have student repeat directions to check for understanding.
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Gifted and Talented-

- Advance, accelerate, or compact content
- Support abstract and advanced higher-level thinking through differentiated questioning
- Allowance for adapting of content for individual student interests
- Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.

- Provide additional time for in-class assignments and assessments

● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
● Modify readings and primary source documents

At Risk-

● Provide small group instruction for identified areas for growth
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- ☑ Demonstrate creativity and innovation.
- ☐ Employ valid and reliable research strategies.
- ☑ Utilize critical thinking to make sense of problems and persevere in solving them.
- ☐ Model integrity, ethical leadership, and effective management.
- ☐ Plan education and career paths aligned to personal goals.
- ☑ Use technology to enhance productivity.
- ☐ Work productively in teams while using cultural global competence.

Unit 5

Integration Techniques and Differential Equations

Summary and Rationale

In this unit, students will learn to set up and solve separable differential equations. Slope fields can be used to represent solution curves to a differential equation and build understanding that there are infinitely many general solutions to a differential equation, varying only by a constant of integration. Students can locate a unique solution relevant to a particular situation, provided they can locate a point on the solution curve. By writing and solving differential equations leading to models for exponential growth and decay and logistic growth bc only, students build understanding of topics introduced in Algebra II and other courses

Recommended Pacing

4.5 Weeks

Standards

FUN-7

Instructional Focus

Unit Essential Questions:
- What is a differential equation and what does it mean to solve one?
- What is a slope field and how does it relate to Euler's Method?
- What is the logistic model?

Unit Enduring Understandings:
- Use anti-derivatives to find both particular and general solutions to differential equations
- Use separation of variables to solve differential equations
- Create slope fields, and use them to sketch particular solutions to differential equations
- Use Euler's method to approximate a function value.
- Recognize and find solutions to the logistic differential equation.

Evidence of Learning (Assessments)

Assign the Progress Checks from AP Course and Exam Description Resource for each unit.
Each Personal Progress Check contains formative multiple-choice and free-response questions.
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Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~8–9 CLASS PERIODS (AB) ~9–10 CLASS PERIODS (BC)
FUN-7	**7.1 Modeling Situations with Differential Equations**	2.C Identify a re-expression of mathematical information presented in a given representation.	
	7.2 Verifying Solutions for Differential Equations	3.G Confirm that solutions are accurate and appropriate.	
	7.3 Sketching Slope Fields	2.C Identify a re-expression of mathematical information presented in a given representation.	
	7.4 Reasoning Using Slope Fields	4.D Use appropriate graphing techniques.	
	7.5 Approximating Solutions Using Euler's Method BC ONLY	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	7.6 Finding General Solutions Using Separation of Variables	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	7.7 Finding Particular Solutions Using Initial Conditions and Separation of Variables	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	7.8 Exponential Models with Differential Equations	3.G Confirm that solutions are accurate and appropriate.	
	7.9 Logistic Models with Differential Equations BC ONLY	3.F Explain the meaning of mathematical solutions in context.	
	Go to **AP Classroom** to assign the **Progress Check** for Unit 7. Review the results in class to identify and address any student misunderstandings.		

Suggested Resources/Technology Tools

College Board AP Website

Modifications

Special Education-

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● Provide small group/ individualized instruction.
● Allow use of assistive technology.
● Anticipate needs; pre-teach if needed.
● Have student repeat directions to check for understanding.
● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

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● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading

Gifted and Talented-

● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

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● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
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At Risk-

● Provide small group instruction for identified areas for growth
● Allow for alternate pathways for completion of assignments.
● Provide additional wait time for student responses to questions
● Pair oral instruction with visuals
● Utilize manipulatives

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Career Readiness, Life Literacies, and Key Skills Practices (June 2020)

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- ☑ Apply appropriate academic and technical skills.
- ☐ Attend to personal health and financial well being.
- ☑ Communicate clearly and effectively and with reason.
- ☑ Consider the environmental, social and economics impacts of decisions.
- ☑ Demonstrate creativity and innovation.
- ☐ Employ valid and reliable research strategies.
- ☑ Utilize critical thinking to make sense of problems and persevere in solving them.
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- ☐ Plan education and career paths aligned to personal goals.
- ☑ Use technology to enhance productivity.
- ☐ Work productively in teams while using cultural global competence.

Unit 6

Applications of Integration

Summary and Rationale

In this unit, students will learn how to find the average value of a function, model particle motion and net change, and determine areas, and volumes defined by the graphs of functions. Students will develop an understanding of integration that can be transferred across these and many other applications. Understanding that the area, and volume problems studied in this unit are limiting cases of Riemann sums of rectangle areas, prism volumes, saves students from memorizing a long list of seemingly unrelated formulas and develops meaningful understanding of integration.

Recommended Pacing

3 Weeks

Standards

CHA-4, CHA-5

Instructional Focus

Unit Essential Questions:

- How do we find the average value of a function?
- How can we use integration to find volumes?
- What does it mean when we integrate an expression representing a rate of change?
- How do we find the length of a curve?
- How we can find the surface area created by revolving a function about an axis?

Unit Enduring Understandings:

- Find the average value of a function and apply the mean value theorem for integrals.
- Find the area bound by two curves.
- Use integration to find volumes through cross sections, disc-method, washer method and cylindrical shells.
- Find the length of a curve and relate it to distance traveled by a particle.
- Understand the utility and meaning of performing integrals around different axes and using vertically or horizontally oriented rectangles, and finding the area created by revolving a function about an axis..
- Find net changes in a function by integrating their rates of change (Accumulation)

Evidence of Learning (Assessments)

Assign the Progress Checks from AP Course and Exam Description Resource for each unit.
Each Personal Progress Check contains formative multiple-choice and free-response questions.
The feedback from the Personal Progress Checks shows students the areas where they need to focus.

Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~19–20 CLASS PERIODS (AB) ~13–14 CLASS PERIODS (BC)
CHA-4	**8.1 Finding the Average Value of a Function on an Interval**	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	8.2 Connecting Position, Velocity, and Acceleration of Functions Using Integrals	1.D Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems.	
	8.3 Using Accumulation Functions and Definite Integrals in Applied Contexts	3.D Apply an appropriate mathematical definition, theorem, or test.	
CHA-5	**8.4 Finding the Area Between Curves Expressed as Functions of x**	4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using $f'(x)$, y', and $\frac{dy}{dx}$).	
	8.5 Finding the Area Between Curves Expressed as Functions of y	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	8.6 Finding the Area Between Curves That Intersect at More Than Two Points	2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.	
	8.7 Volumes with Cross Sections: Squares and Rectangles	3.D Apply an appropriate mathematical definition, theorem, or test.	
	8.8 Volumes with Cross Sections: Triangles and Semicircles	3.D Apply an appropriate mathematical definition, theorem, or test.	
	8.9 Volume with Disc Method: Revolving Around the x- or y-Axis	3.D Apply an appropriate mathematical definition, theorem, or test.	

Enduring Understanding	Topic	Suggested Skills	Class Periods ~19–20 CLASS PERIODS (AB) ~13–14 CLASS PERIODS (BC)
CHA-5	**8.10 Volume with Disc Method: Revolving Around Other Axes**	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	
	8.11 Volume with Washer Method: Revolving Around the x- or y-Axis	4.E Apply appropriate rounding procedures.	
	8.12 Volume with Washer Method: Revolving Around Other Axes	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	

Suggested Resources/Technology Tools

College Board AP Website

Modifications

Special Education-

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- Allow additional time for skill mastery.
- Provide small group/ individualized instruction.
- Allow use of assistive technology.
- Anticipate needs; pre-teach if needed.
- Have student repeat directions to check for understanding.
- Highlight text/ visual presentation.
- Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

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Gifted and Talented-

- Advance, accelerate, or compact content
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504-

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- Modify readings and primary source documents

At Risk-

- Provide small group instruction for identified areas for growth
- Allow for alternate pathways for completion of assignments.
- Provide additional wait time for student responses to questions
- Pair oral instruction with visuals
- Utilize manipulatives

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Career Readiness, Life Literacies, and Key Skills Practices (June 2020)

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- ☐ Work productively in teams while using cultural global competence.

Unit 7

Parametric Equations, Polar Equations and Vectors

Summary and Rationale

In this unit, students will build on their understanding of straight-line motion to solve problems in which particles are moving along curves in the plane. Students will define parametric equations and vector-valued functions to describe planar motion and apply calculus to solve motion problems. Students will learn that polar equations are a special case of parametric equations and will apply calculus to analyze graphs and determine lengths and areas. Have students treat this unit as an opportunity to reinforce past learning and transfer knowledge and skills to new situations, rather than as a new list of facts or strategies to memorize.

Recommended Pacing

4 Weeks

Standards

CHA-3, CHA-6, FUN-3, FUN-8, CHA-5

Instructional Focus

Unit Essential Questions:

- What is a parametric or polar equation and how do we have to adjust our calculus to deal with them?
- What is a vector and how does it contrast with a scalar?

Unit Enduring Understandings:

- Take the derivative and second derivative of parametric and polar equations.
- Convert parametric and polar equations to rectangular coordinates (when possible) and back.
- Calculute curve length for both parametric and polar equations.
- Integrate polar curves and find area bound between multiple curves.
- Perform basic calculus on position, velocity and acceleration vectors.
- Perform dot and cross products on vectors and understand their meanings

Evidence of Learning (Assessments)

Assign the Progress Checks from AP Course and Exam Description Resource for each unit.
Each Personal Progress Check contains formative multiple-choice and free-response questions.
The feedback from the Personal Progress Checks shows students the areas where they need to focus.

Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~10–11 CLASS PERIODS
CHA-3	9.1 Defining and Differentiating Parametric Equations	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	
	9.2 Second Derivatives of Parametric Equations	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
CHA-6	9.3 Finding Arc Lengths of Curves Given by Parametric Equations	1.D Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems.	
CHA-3	9.4 Defining and Differentiating Vector-Valued Functions	1.D Identify an appropriate mathematical rule or procedure based on the relationship between concepts (e.g., rate of change and accumulation) or processes (e.g., differentiation and its inverse process, anti-differentiation) to solve problems.	
FUN-8	9.5 Integrating Vector-Valued Functions	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
	9.6 Solving Motion Problems Using Parametric and Vector-Valued Functions	1.E Apply appropriate mathematical rules or procedures, with and without technology.	
FUN-3	9.7 Defining Polar Coordinates and Differentiating in Polar Form	2.D Identify how mathematical characteristics or properties of functions are related in different representations.	
CHA-5	9.8 Find the Area of a Polar Region or the Area Bounded by a Single Polar Curve	3.D Apply an appropriate mathematical definition, theorem, or test.	
	9.9 Finding the Area of the Region Bounded by Two Polar Curves	3.D Apply an appropriate mathematical definition, theorem, or test.	

Suggested Resources/Technology Tools

College Board AP Website

Modifications

Special Education-
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● Provide small group/ individualized instruction.
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● Anticipate needs; pre-teach if needed.
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● Highlight text/ visual presentation.
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At Risk-
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- ☑ Demonstrate creativity and innovation.
- ☐ Employ valid and reliable research strategies.
- ☑ Utilize critical thinking to make sense of problems and persevere in solving them.
- ☐ Model integrity, ethical leadership, and effective management.
- ☐ Plan education and career paths aligned to personal goals.

- [x] Use technology to enhance productivity.
- [ ] Work productively in teams while using cultural global competence.

Unit 8

Sequences and Series

Summary and Rationale

In this unit, students need to understand that a sum of infinitely many terms may converge to a finite value. They can develop intuition by exploring graphs, tables, and symbolic expressions for series that converge and diverge and for Taylor polynomials. Students should build connections to past learning, such as how evaluating improper integrals relates to the integral test or how using limiting cases of power series to represent continuous functions relates to differentiation and integration. Students who rely solely on memorizing a long list of tests and procedures typically find little success achieving a lasting conceptual understanding of series.

Recommended Pacing

6 Weeks

Standards

LIM-7, LIM-8

Instructional Focus

Unit Essential Questions:
- How can we model a complex function with a simpler one?
- How can we analyze a sum of an infinite number of terms

Unit Enduring Understandings:
- Identify the convergence or divergence of an infinite sequence or series.
- Determine the interval of convergence of an infinite series.
- Create a Power series to model a function.
- Use knowledge of geometric series or derivatives (Taylor series) to create the power series.
- Create a power series for a more complicated function by using known power series for more basic functions.
- Find an error bound for an approximation of a function when applying a finite series by either use of an alternating series error bound or a Lagrange error bound.

Evidence of Learning (Assessments)

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Objectives (SLO)

Enduring Understanding	Topic	Suggested Skills	Class Periods ~17–18 CLASS PERIODS
LIM-7	**10.1 Defining Convergent and Divergent Infinite Series**	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.2 Working with Geometric Series	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.3 The *n*th Term Test for Divergence	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.4 Integral Test for Convergence	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.5 Harmonic Series and *p*-Series	3.B Identify an appropriate mathematical definition, theorem, or test to apply.	
	10.6 Comparison Tests for Convergence	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.7 Alternating Series Test for Convergence	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.8 Ratio Test for Convergence	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.9 Determining Absolute or Conditional Convergence	3.D Apply an appropriate mathematical definition, theorem, or test.	
	10.10 Alternating Series Error Bound	1.E Apply appropriate mathematical rules or procedures, with and without technology.	

LIM-8	**10.11 Finding Taylor Polynomial Approximations of Functions**	3.D Apply an appropriate mathematical definition, theorem, or test. 2.C Identify a re-expression of mathematical information presented in a given representation.	
	10.12 Lagrange Error Bound	1.F Explain how an approximated value relates to the actual value.	
	10.13 Radius and Interval of Convergence of Power Series	2.C Identify a re-expression of mathematical information presented in a given representation.	
	10.14 Finding Taylor or Maclaurin Series for a Function	2.C Identify a re-expression of mathematical information presented in a given representation.	
	10.15 Representing Functions as Power Series	3.D Apply an appropriate mathematical definition, theorem, or test.	

Suggested Resources/Technology Tools

College Board AP Website

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