Wall Township Public Schools	Board Approval Date: 8/19/2025

Course Title: AP Calculus AB

Course Description: Students learn to appreciate the value of calculus as the mathematics of change and motion. This course prepares students for further study in all branches of higher mathematics, science and related fields. The course emphasizes an approach to calculus that involves problems being expressed numerically, analytically, graphically and verbally. Technology is used regularly to reinforce these approaches to confirm written work, to implement experimentation and assist in interpreting results. This course is equivalent to a college Calculus 1 course.

New Jersey Student Learning Standards - Math

Vision for Mathematics Education in New Jersey

A New Jersey education in Mathematics builds quantitatively and analytically literate citizens prepared to meet the demands of college and career, and to engage productively in an information-driven society. All students will have access to a high-quality mathematics education that fosters a population that:

- leverages data in decision-making and as a lens for discussing, analyzing, and responding to practical questions.
- persists to make sense of and model problems arising in everyday life, society, and the workplace.
- thinks critically and strategically to assess quantitative relationships and to solutions to complex problems.
- employs precise reasoning and constructs viable arguments to deduce conclusions, recognize false statements and assess peers' reasoning.
- interprets, evaluates and critiques the mathematics embedded in social, scientific and commercial systems, as well as the claims made in the private and public sectors.
- communicates precisely when conveying, representing, and justifying both qualitative and quantitative perspectives.

Standards for Mathematical Practice*

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report Adding It Up: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

**See end of document for additional information related to the mathematical practices.*

Inclusion of Climate Change Opportunities

( ) notes opportunities to integrate specific examples of climate change education provided by additional age-appropriate resources

The goal of inclusion of climate change education implementation is to foster generations of New Jersey students that can analyze, question, interpret, to think independently, and bring critical deduction to fulfill, and to lead in jobs created by burgeoning industries of the future green economy.

Course Sequence & Pacing	
Unit Title	**Estimated Number of Instructional Periods**
Unit 1: Limits and Continuity	12
Unit 2: Understanding the Derivative	12
Unit 3: Rules of Differentiation	15
Unit 4: Applications of Differentiation Part I	15
Unit 5: Applications of Differentiation Part II	11
Unit 6: Integration	15
Unit 7: Applications of Integration Part I	15
Unit 8: Applications of Integration Part II	15
Unit 9: Project Calculus	15

Current instructional periods are 56 minutes and meet 3 times every 4 days.

Unit 1

Desired Results

Unit 1: Limits and Continuity

Unit Summary: Limits are the foundational concept of calculus. This unit features a multi-representational approach to calculus, with limits, continuity, and their connected theorems expressed graphically, numerically, analytically, and verbally. Exploring connections among these representations builds understanding of how calculus applies limits to develop important ideas, definitions, formulas, and theorems.

Learning Standards

- Mathematical Practice 1- Implementing Mathematical Processes
  - 1.A Identify the question to be answered or problem to be solved (not assessed)
  - 1.B Identify key and relevant information to answer a question or solve a problem (not assessed)
  - 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.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.
  - 1.E Apply appropriate mathematical rules or procedures, with and without technology.
  - 1.F Explain how an approximated value relates to the actual value.
- Mathematical Practice 2- Connecting Representations
  - 2.A Identify common underlying structures in problems involving different contextual situations.
  - 2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.
  - 2.C Identify a re-expression of mathematical information presented in a given representation.
  - 2.D Identify how mathematical characteristics or properties of functions are related in different representations.
  - 2.E Describe the relationships among different representations of functions and their derivatives.
- Mathematical Practice 3- Justification
  - 3.A Apply technology to develop claims and conjectures (not assessed).

- 3.B Identify an appropriate mathematical definition, theorem, or test to apply
- 3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.
- 3.D Apply an appropriate mathematical definition, theorem, or test.
- 3.E Provide reasons or rationales for solutions and conclusions.
- 3.F Explain the meaning of mathematical solutions in context.
- 3.G Confirm that solutions are accurate and appropriate.

- Mathematical Practice 4- Communication and Notation
  - 4.A Use precise mathematical language.
  - 4.B Use appropriate units of measure
  - 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f '(x), y', and dy/dx).
  - 4.D Use appropriate graphing techniques.
  - 4.E Apply appropriate rounding procedures.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

Computer Science & Design Thinking (*CS & DT***):**

- Practice 2 Collaborating Around Computing and Design
  - Collaborative computing is the process of performing a computational task by working on pairs in teams. Because it involves asking for the contributions and feedback of others, effective collaboration can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities. Students should use collaborative tools to effectively work together and to create complex artifacts. When engaging in this practice, students:

- Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.
- Create team norms, expectations, and equitable workloads to increase efficiency and effectiveness.
- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- How does the math that you previously studied relate to the math that you are going to be studying?
- How do limits guarantee the continuity of a function?
- When do limits fail to exist?
- How are limits connected to the existence of vertical and horizontal asymptotes?
- What is the difference between calculating a limit and evaluating a function at a point?
- What are connections among these presentations of functions; graphically, numerically, analytically or verbally?

Unit Enduring Understandings:

- Calculus is the study of the rate of change of values and allows us to find length, area, and volume.
- A limit is the foundation of both differential and integral calculus.
- Continuity is defined by limits and is a prerequisite for many applications in calculus.

Vocabulary: Domain, range, independent, dependent variable, graph, function, absolute value, increasing, decreasing, linear ,quadratic, polynomial, coefficients, degree, cubic , power, root,, reciprocal , rational, algebraic, trigonometric, exponential, logarithmic , translations, composite , limit, right-hand limit, left-hand limit, vertical asymptote, continuous at a point, discontinuity, removable discontinuity, jump discontinuity, horizontal asymptote, infinite

limits, limits at infinity, intermediate value theorem

Students will be able to:

- Evaluate, if it exists, the value of a limit from a graphical approach, including one-sided limits.
- Evaluate limits analytically, including direct substitution, cancellation and rationalization, applying the properties of limits.
- Evaluate limits of trigonometric functions analytically.
- Graphically and analytically, apply the three part definition of continuity to determine if a function is continuous at a point.
- Understand and apply the intermediate value theorem.
- Distinguish between infinite limits and limits at infinity, and use them to identify asymptotes

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Assessments

- AP Classroom Progress Checks

Alternative Assessments:

- Modified Unit Assessments
- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Deltamath
- Khan Academy
- AP Classroom

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:

Students receiving Special Education programming have specific goals and objectives, as well as accommodations and modifications outlined within their Individualized Education Plans (IEP) due to an identified disability and/or diagnosis. In addition to exposure to the general education curriculum, the instruction is differentiated based upon the student's needs. The IEP acts as a supplemental curriculum guide inclusive of instructional strategies that support each learner.

- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback
-Alternate or reduced work within Digital Platforms such as Deltamath

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling -

Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups
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Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice
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Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning
-Enrichment/Extension Activities within Digital Platforms such as Deltamath

Unit 2

Desired Results

Unit 2: Understanding the Derivative

Unit Summary: In this unit, students develop a foundational understanding of derivatives by learning to express them as limits of difference quotients. They estimate derivative values graphically and numerically and use them to write equations of tangent lines. Students analytically differentiate polynomial, sine, and cosine functions and apply these derivatives to determine tangent lines, intervals of increase/decrease, and relative extrema. The unit emphasizes the interpretation of the derivative as the slope of the tangent line.

Learning Standards

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  - 1.B Identify key and relevant information to answer a question or solve a problem (not assessed)
  - 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).
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  - 1.E Apply appropriate mathematical rules or procedures, with and without technology.
  - 1.F Explain how an approximated value relates to the actual value.
- Mathematical Practice 2- Connecting Representations
  - 2.A Identify common underlying structures in problems involving different contextual situations.
  - 2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.
  - 2.C Identify a re-expression of mathematical information presented in a given representation.
  - 2.D Identify how mathematical characteristics or properties of functions are related in different representations.

- 2.E Describe the relationships among different representations of functions and their derivatives.
- Mathematical Practice 3- Justification
  - 3.A Apply technology to develop claims and conjectures (not assessed).
  - 3.B Identify an appropriate mathematical definition, theorem, or test to apply
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- Mathematical Practice 4- Communication and Notation
  - 4.A Use precise mathematical language.
  - 4.B Use appropriate units of measure
  - 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f'(x), y', and dy/dx).
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Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

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- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
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Computer Science & Design Thinking *(**CS & DT*****)*:**

- Practice 2 Collaborating Around Computing and Design
  - Collaborative computing is the process of performing a computational task by working on pairs in teams. Because it involves asking for the contributions and feedback of others, effective collaboration can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities.

Students should use collaborative tools to effectively work together and to create complex artifacts. When engaging in this practice, students:

- Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.
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- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- Why is the derivative important?
- How is the average rate of change related to the instantaneous rate of change?
- How is the derivative related to the tangent line to a curve?

Unit Enduring Understandings:

- The derivative of a function is defined as the limit of a difference quotient and can be determined using a variety of strategies.
- A function's derivative, which itself is a function, can be used to understand the behavior of a function.

Vocabulary: definition of derivative, difference quotient, tangent line, normal line, average rate of change, instantaneous rate of change, derivative, power rule, relative extrema, relative maximum, relative minimum, absolute extrema, absolute maximum, absolute minimum, tangent line approximation, L'Hopital's Rule

Students will be able to:

- Find an equation of the derivative of a function as a limit of the difference quotient.
- Estimate the value of the derivative of a function at a point graphically and numerically and use the value of the derivative to find an equation of a tangent line drawn to the graph of a function.

- Analytically find the derivative of a polynomial, sine, or cosine function, and use it to find the equation of a tangent line.
- Analytically find the first derivative of a polynomial, sine, or cosine function and use it to find intervals of increasing, decreasing, and relative maximums/minimums for the graph of the function.
- Solidify the concept of the derivative being the tangent line and learn to approximate the value of a function using the equation of the tangent line.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Quiz 3
- Classwork

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Unit 3

Desired Results

Unit 3: Rules of Differentiation

Unit Summary: In this unit, students explore advanced differentiation methods including the product, quotient, and chain rules, applied analytically, graphically, and numerically. They derive and use rules for all trigonometric functions and inverse functions, and differentiate exponential and natural logarithmic functions. Students use graphing calculators to estimate and interpret derivatives and examine the link between continuity and differentiability. The unit concludes with an introduction to L'Hôpital's Rule for evaluating indeterminate limits.

Learning Standards

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- Mathematical Practice 3- Justification
    - 3.A Apply technology to develop claims and conjectures (not assessed).
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Interdisciplinary Connections

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Learning Targets

Unit Essential Questions:

- Why is the derivative important?
- What is the connection between differentiability and continuity?

Unit Enduring Understandings:

- The derivative of a function can be determined using a variety of strategies.
- A function's derivative, which itself is a function, can be used to understand the behavior of a function

Vocabulary: definition of derivative, difference quotient, tangent line, normal line, average rate of change, instantaneous rate of change, derivative, power rule, product rule, quotient rule, chain rule, trigonometric rules, exponential rules, logarithmic differentiation, inverse trigonometric rules, differentiable, first derivative test

Students will be able to:

- Apply the product rule of differentiation analytically, graphically, and numerically.
- Apply the quotient rule of differentiation analytically, graphically, and numerically and derive the

differentiation rules for tangent, cotangent, secant, and cosecant.

- Apply the chain rule of differentiation analytically, graphically, and numerically and derive the differentiation rule for an inverse function.
- Analytically determine the derivative of exponential functions whose bases are e and natural logarithmic functions.
- Numerically determine and interpret the value of the derivative of a function using the graphing calculator.
- Apply L'Hopital's Rule to evaluate limits.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
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Unit 4

Desired Results

Unit 4: Applications of the Derivative Part I

Unit Summary: In this unit, students use graphing calculators to estimate derivatives and explore the connection between continuity and differentiability. They apply first and second derivatives to identify intervals of increase/decrease, concavity, extrema, and inflection points. The relationships among f(x), f′(x), and f′′(x) are examined both graphically and numerically. Students also distinguish between average and instantaneous rates of change, applying the Mean Value and Extreme Value Theorems in various contexts.

Learning Standards

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- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

Computer Science & Design Thinking *(**CS & DT*)**:

- Practice 2 Collaborating Around Computing and Design
  - Collaborative computing is the process of performing a computational task by working on pairs in teams. Because it involves asking for the contributions and feedback of others, effective collaboration can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities. Students should use collaborative tools to effectively work together and to create complex artifacts. When engaging in this practice, students:

- Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.
- Create team norms, expectations, and equitable workloads to increase efficiency and effectiveness.
- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- What does a derivative tell us about a function?
- How can the derivative be used to solve optimization problems?
- How do rates of change relate in real-life settings?

Unit Enduring Understandings:

- The derivative has both theoretical and real life applications.
- The derivative provides useful information about the behavior of functions and the shapes of graphs.
- Understanding the rate of change of a function allows you to predict future behavior.

Vocabulary: Diffentiability, concavity, point of inflection, Extreme Value Theorem, Mean Value Theorem, instantaneous rate of change, average rate of change

Students will be able to:

- Numerically determine and interpret the value of the derivative of a function using the graphing calculator.
- Understand the relationship between differentiability and continuity.
- Use the first and second derivative of a function to analytically determine intervals of increasing/decreasing, concave up/down, coordinates of relative extrema, and coordinates of points of

inflection.

- Understand the graphical and numerical connections between the graphs of F(x), F'(x), and F''(x).
- Review relationships between f and f ' to understand and apply the Extreme Value Theorem, and, extending these to f''.
- Distinguish between the instantaneous rate of change of a function at a point and the average rate of change of a function on an interval, extending these ideas to understand and apply the Mean Value Theorem.
- Apply major theorems numerically, graphically, and verbally.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Quiz 3
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Assessments
- AP Classroom Progress Checks

Alternative Assessments:

- Modified Unit Assessments
- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Deltamath
- Khan Academy
- AP Classroom

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
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-Alternate or reduced work within Digital Platforms such as Deltamath

Specific Strategies and Practices that Support English Language Learners
English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups

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Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice
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Students with 504 Plans

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Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning
-Enrichment/Extension Activities within Digital Platforms such as Deltamath

Unit 5

Desired Results

Unit 5: Applications of Derivatives Part II

Unit Summary: This unit focuses on applying derivatives in real-world and abstract contexts. Students learn to differentiate implicitly defined equations and solve related rates problems involving changing quantities over time. They also use calculus to solve optimization problems, finding maximum or minimum values in applied scenarios.

Learning Standards

- Mathematical Practice 1- Implementing Mathematical Processes
  - 1.A Identify the question to be answered or problem to be solved (not assessed)
  - 1.B Identify key and relevant information to answer a question or solve a problem (not assessed)
  - 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.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.
  - 1.E Apply appropriate mathematical rules or procedures, with and without technology.
  - 1.F Explain how an approximated value relates to the actual value.
- Mathematical Practice 2- Connecting Representations
  - 2.A Identify common underlying structures in problems involving different contextual situations.
  - 2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.
  - 2.C Identify a re-expression of mathematical information presented in a given representation.
  - 2.D Identify how mathematical characteristics or properties of functions are related in different representations.
  - 2.E Describe the relationships among different representations of functions and their derivatives.
- Mathematical Practice 3- Justification

- 3.A Apply technology to develop claims and conjectures (not assessed).
- 3.B Identify an appropriate mathematical definition, theorem, or test to apply
- 3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.
- 3.D Apply an appropriate mathematical definition, theorem, or test.
- 3.E Provide reasons or rationales for solutions and conclusions.
- 3.F Explain the meaning of mathematical solutions in context.
- 3.G Confirm that solutions are accurate and appropriate.

- Mathematical Practice 4- Communication and Notation
  - 4.A Use precise mathematical language.
  - 4.B Use appropriate units of measure
  - 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f '(x), y', and dy/dx).
  - 4.D Use appropriate graphing techniques.
  - 4.E Apply appropriate rounding procedures.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
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- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- How can the derivative be used to solve optimization problems?
- How do rates of change relate in real-life settings?

Unit Enduring Understandings:

- The derivative has both theoretical and real life applications.
- The derivative provides useful information about the behavior of functions and the shapes of graphs.
- Understanding the rate of change of a function allows you to predict future behavior.

Vocabulary: Optimization, Extreme Value Theorem, Mean Value Theorem

Students will be able to:

- Differentiate equations that are implicitly defined.
- Solve related rate problems.
- Solve optimization—applied maximum and minimum—problems.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Quiz 3
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Assessments
- AP Classroom Progress Checks

Alternative Assessments:

- Modified Unit Assessments
- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Deltamath
- Khan Academy
- AP Classroom

Accommodations and Modifications:
Students with Disabilities, English Language Learners,
Students at Risk of Failure, Students with 504s, Gifted & Talented Students

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Unit 6

Desired Results

Unit 6: Integration

Unit Summary: In this unit, students learn to find antiderivatives (indefinite integrals) of polynomial and trigonometric functions. They approximate the area under curves using Riemann sums and Trapezoidal sums from graphs and data. The unit focuses on understanding and applying the Fundamental Theorem of Calculus (Part 1), exploring the properties of definite integrals and interpreting them as the total accumulation of change over an interval. Students also apply the theorem to calculate the average value of a function on a given interval.

Learning Standards

- Mathematical Practice 1- Implementing Mathematical Processes
  - 1.A Identify the question to be answered or problem to be solved (not assessed)
  - 1.B Identify key and relevant information to answer a question or solve a problem (not assessed)
  - 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.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.
  - 1.E Apply appropriate mathematical rules or procedures, with and without technology.
  - 1.F Explain how an approximated value relates to the actual value.
- Mathematical Practice 2- Connecting Representations
  - 2.A Identify common underlying structures in problems involving different contextual situations.
  - 2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.
  - 2.C Identify a re-expression of mathematical information presented in a given representation.
  - 2.D Identify how mathematical characteristics or properties of functions are related in different representations.

- 2.E Describe the relationships among different representations of functions and their derivatives.
- Mathematical Practice 3- Justification
  - 3.A Apply technology to develop claims and conjectures (not assessed).
  - 3.B Identify an appropriate mathematical definition, theorem, or test to apply
  - 3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.
  - 3.D Apply an appropriate mathematical definition, theorem, or test.
  - 3.E Provide reasons or rationales for solutions and conclusions.
  - 3.F Explain the meaning of mathematical solutions in context.
  - 3.G Confirm that solutions are accurate and appropriate.
- Mathematical Practice 4- Communication and Notation
  - 4.A Use precise mathematical language.
  - 4.B Use appropriate units of measure
  - 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f '(x), y', and dy/dx).
  - 4.D Use appropriate graphing techniques.
  - 4.E Apply appropriate rounding procedures.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
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- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
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- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- How are the rules for differentiation used to develop the basic rules of integration?
- How can we use the measure of area under a curve to discuss net change of a function over time?
- How is the antiderivative related to the accumulation function?

Unit Enduring Understandings:

- Derivatives and antiderivatives have an inverse relationship to each other.
- The definite integral of a function over an interval is the limit of a Riemann sum over that interval and can be calculated using a variety of strategies.
- The anti-derivative has both theoretical and real life applications.

Vocabulary: Antiderivative, particular solution, general solution, constant of integration, indefinite integral, variable of integration, definite integral, limits of integration, Riemann sum(left, right, midpoint), trapezoidal rule, under the curve, average value

Students will be able to:

- Find antiderivatives/indefinite integrals of polynomial-type and trigonometric functions.
- Approximate the area between a curve and the x-axis using Riemann and Trapezoidal Sums from graphs and

tables of values.
- Learn and apply the Fundamental Theorem of Calculus, Part 1.
- Understand and apply the properties of definite integrals and apply the First Fundamental Theorem numerically and graphically.
- Finding integrals by substitution, including changing of variables and limits of integration.
- Understand and use the Second Fundamental Theorem of Calculus and functions defined by integrals.
- Apply the Fundamental Theorem of Calculus to find the average value of a function on an interval.
- Finding integrals by substitution, including changing of variables and limits of integration.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Projects

Alternative Assessments:

- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Deltamath
- Khan Academy
- AP Classroom

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

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Specific Strategies and Practices that Support Gifted & Talented Students

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Unit 7

Desired Results

Unit 7: Applications of Integration Part I

Unit Summary: In this unit, students interpret the definite integral as the total accumulation of change over time. They apply the Fundamental Theorem of Calculus to find the average value of functions and analyze motion using calculus concepts such as average and instantaneous velocity and acceleration. Students also calculate net and total distance traveled by a particle over a given interval.

Learning Standards

- Mathematical Practice 1- Implementing Mathematical Processes
  - 1.A Identify the question to be answered or problem to be solved (not assessed)
  - 1.B Identify key and relevant information to answer a question or solve a problem (not assessed)
  - 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).
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  - 1.E Apply appropriate mathematical rules or procedures, with and without technology.
  - 1.F Explain how an approximated value relates to the actual value.
- Mathematical Practice 2- Connecting Representations
  - 2.A Identify common underlying structures in problems involving different contextual situations.
  - 2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.
  - 2.C Identify a re-expression of mathematical information presented in a given representation.
  - 2.D Identify how mathematical characteristics or properties of functions are related in different representations.
  - 2.E Describe the relationships among different representations of functions and their derivatives.

- Mathematical Practice 3- Justification
    - 3.A Apply technology to develop claims and conjectures (not assessed).
    - 3.B Identify an appropriate mathematical definition, theorem, or test to apply
    - 3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.
    - 3.D Apply an appropriate mathematical definition, theorem, or test.
    - 3.E Provide reasons or rationales for solutions and conclusions.
    - 3.F Explain the meaning of mathematical solutions in context.
    - 3.G Confirm that solutions are accurate and appropriate.
- Mathematical Practice 4- Communication and Notation
    - 4.A Use precise mathematical language.
    - 4.B Use appropriate units of measure
    - 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f '(x), y', and dy/dx).
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Learning Targets

Unit Essential Questions:

- How are the rules for differentiation used to develop the basic rules of integration?
- How can we use the measure of area under a curve to discuss net change of a function over time?
- How is the antiderivative related to the accumulation function?

Unit Enduring Understandings:

- Derivatives and antiderivatives have an inverse relationship to each other.
- The definite integral of a function over an interval is the limit of a Riemann sum over that interval and can be calculated using a variety of strategies.
- The anti-derivative has both theoretical and real life applications.

Vocabulary: Average value, average velocity, average acceleration, instantaneous velocity, instantaneous acceleration, total distance, net distance

Students will be able to:

- Understand the definite integral to be the total accumulation of change of a function over an interval of time.
- Apply the Fundamental Theorem of Calculus to find the average value of a function on an interval.

- Learn and apply the basic ideas—average velocity, average acceleration, instantaneous velocity, instantaneous acceleration—of motion and how they relate to calculus.
- Find net and total distance of a moving particle over a given interval.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Classwork

Summative Assessments:

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Alternative Assessments:

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Unit 8

Desired Results

Unit 8: Applications of Integration Part II

Unit Summary: This unit explores how integrals are used to calculate area and volume. Students find the area between curves and determine volumes of solids using the disk method and known cross sections. They also solve differential equations, both general and particular solutions, and interpret slope fields as visual representations of those solutions.

Learning Standards

- Mathematical Practice 1- Implementing Mathematical Processes
  - 1.A Identify the question to be answered or problem to be solved (not assessed)
  - 1.B Identify key and relevant information to answer a question or solve a problem (not assessed)
  - 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.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.
  - 1.E Apply appropriate mathematical rules or procedures, with and without technology.
  - 1.F Explain how an approximated value relates to the actual value.
- Mathematical Practice 2- Connecting Representations
  - 2.A Identify common underlying structures in problems involving different contextual situations.
  - 2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.
  - 2.C Identify a re-expression of mathematical information presented in a given representation.
  - 2.D Identify how mathematical characteristics or properties of functions are related in different representations.
  - 2.E Describe the relationships among different representations of functions and their derivatives.

- Mathematical Practice 3- Justification
    - 3.A Apply technology to develop claims and conjectures (not assessed).
    - 3.B Identify an appropriate mathematical definition, theorem, or test to apply
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    - 3.G Confirm that solutions are accurate and appropriate.
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    - 4.A Use precise mathematical language.
    - 4.B Use appropriate units of measure
    - 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f '(x), y', and dy/dx).
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Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

Computer Science & Design Thinking *(CS & DT)*:

- Practice 2 Collaborating Around Computing and Design
    - Collaborative computing is the process of performing a computational task by working on pairs in teams. Because it involves asking for the contributions and feedback of others, effective collaboration can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities. Students

should use collaborative tools to effectively work together and to create complex artifacts. When engaging in this practice, students:

- Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.
- Create team norms, expectations, and equitable workloads to increase efficiency and effectiveness.
- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- What characteristics of certain functions lend themselves naturally to one method but not another?
- How can one approximate a solution to differential equations graphically?
- How can integrals be used to find volumes of complex figures?
- What are the practical applications of finding such volumes?

Unit Enduring Understandings:

- Antidifferentiation is an underlying concept involved in solving separable differential equations.
- Solving differential equations involves determining a function or relation given its rate of change.
- The definite integral can be used to find exact area, volume, or length by using the limit of Riemann sums.

Vocabulary: Differential equation, constant of integration, exponential growth and decay, slope field, area, cross-section, volume, disc method, washer method

Students will be able to:

- Find the area between two curves.

- Find volumes of solids of revolution using the disk method.
- Calculate volumes of solids of known cross sections.
- Find general and particular solutions for differential equations.
- Identify and create slope fields that represent the general solutions of differential equations.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Projects

Alternative Assessments:

- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Deltamath
- Khan Academy
- AP Classroom

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:

Students receiving Special Education programming have specific goals and objectives, as well as accommodations and modifications outlined within their Individualized Education Plans (IEP) due to an identified disability and/or diagnosis. In addition to exposure to the general education curriculum, the instruction is differentiated based upon the student's needs. The IEP acts as a supplemental curriculum guide inclusive of instructional strategies that support each learner.

- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice

Students with 504 Plans

Teachers are responsible for implementing designated services and strategies identified on a student's 504 Plan.
504 plans are formal plans that schools develop to give kids the support they need and covers any condition that limits daily activities in a major way. Students' accommodations are outlined in their individual 504 plan.

Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning

Unit 9

Desired Results

Unit 9: Project Calculus

Unit Summary: In this unit students will explore an appreciation of mathematics and calculus as a coherent body of knowledge. Students will complete various projects covering the AP Calculus exam, communicating calculus, and extending calculus to real life. Students will work in groups throughout this unit.

Learning Standards

- Mathematical Practice 1- Implementing Mathematical Processes
  - 1.A Identify the question to be answered or problem to be solved (not assessed)
  - 1.B Identify key and relevant information to answer a question or solve a problem (not assessed)
  - 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.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.
  - 1.E Apply appropriate mathematical rules or procedures, with and without technology.
  - 1.F Explain how an approximated value relates to the actual value.
- Mathematical Practice 2- Connecting Representations
  - 2.A Identify common underlying structures in problems involving different contextual situations.
  - 2.B Identify mathematical information from graphical, numerical, analytical, and/or verbal representations.
  - 2.C Identify a re-expression of mathematical information presented in a given representation.
  - 2.D Identify how mathematical characteristics or properties of functions are related in different representations.
  - 2.E Describe the relationships among different representations of functions and their derivatives.
- Mathematical Practice 3- Justification

- 3.A Apply technology to develop claims and conjectures (not assessed).
- 3.B Identify an appropriate mathematical definition, theorem, or test to apply
- 3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.
- 3.D Apply an appropriate mathematical definition, theorem, or test.
- 3.E Provide reasons or rationales for solutions and conclusions.
- 3.F Explain the meaning of mathematical solutions in context.
- 3.G Confirm that solutions are accurate and appropriate.

- Mathematical Practice 4- Communication and Notation
  - 4.A Use precise mathematical language.
  - 4.B Use appropriate units of measure
  - 4.C Use appropriate mathematical symbols and notation (e.g., Represent a derivative using f '(x), y', and dy/dx).
  - 4.D Use appropriate graphing techniques.
  - 4.E Apply appropriate rounding procedures.

Interdisciplinary Connections

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Learning Targets

Unit Essential Questions:

- How can calculus be used to solve problems in business, economics, biology, and physics?
- How is calculus the mathematics of change?
- How are the integral and derivative related and to what real world application problems do they provide the answer?

Unit Enduring Understandings:

- Calculus develops one's understanding of the concepts of functions, graphs, limits, derivatives and integrals and provides experience with its methods and applications.
- Mathematical ideas interconnect and build on one another to produce a coherent whole.

Vocabulary: limit, derivative, integral

Students will be able to:

- Apply knowledge of calculus: including limits, derivatives, and integrals to solve practical applications.
- Use software such as Google Docs, Sheets, and Slides
- Summarize their calculus knowledge in their own words.
- Develop an appreciation of mathematics as a coherent body of knowledge and human accomplishment.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

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Alternative Assessments:

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- Other Modified Assessments

Core Instructional & Supplemental Materials

- Google Platform
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