Wall Township Public Schools	Board Approval Date:
Course Title: AP Calculus BC	
Course Description: Students continue their study of Calculus continuing with more complex integration and more advanced applications of derivatives, sequences and power series. Students make regular use of the graphing calculator to reinforce these approaches to confirm written work, to implement experimentation and to assist in interpreting results. This course is equivalent to a college Calculus 2 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	17
Unit 2: Differentiation	27
Unit 3: Integration	29
Unit 4: Parametric and Polar Equations	20
Unit 5: Infinite Series	27
Unit 6: Project Calculus	15

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:	**Unit Enduring Understandings:**
• Why are limits the foundation of calculus and how are they useful? • How do limits relate to various features of a function and its graph? • How is continuity used to identify the existence of important values of a function?	• 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: limit, slope, continuity, average, instantaneous, difference quotient, tangent

Students will be able to:

- Understand the informal definition of a limit and definition of continuous.
- Translate among verbal, visual, and algebraic definitions of limits and continuity.

- Evaluate limits using the squeeze theorem.
- Apply the intermediate value theorem.
- Estimate the slope of a line tangent to a given point.
- Estimate the average velocity and instantaneous velocity at a given time.
- Determine the limit of a function by applying the limit laws.
- Evaluate limits approaching infinity.
- Evaluate indeterminate limits, particularly those of difference quotients algebraically.
- Apply the definition of continuity.
- Calculate slopes of tangents, velocities, and other rates of change by applying the learned techniques to compute limits

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities
  - Limits and Continuity Card Sort Activity
  - Odd Limit Out Activity
  - Two Truths and a Lie- Find the Error Activity
  - Limits Stations Activity

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

- Math Ixl
- 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
-Alternate or reduced work within Digital Platforms such as Deltamath

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
-Alternate or reduced work within Digital Platforms such as Deltamath

Students with 504 Plans

Teachers are responsible for implementing designated services and strategies identified on a student's 504 Plan.
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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: Differentiation

Unit Summary: Differentiation is the mathematical study of change and is a fundamental operation of calculus. This unit features a multi-representational approach to calculus, with limits, derivatives, and their associated theorems expressed graphically, numerically, analytically, and verbally. Exploring connections among these representations builds understanding to describe rates of change of one variable with respect to another and will lead to using definite integrals to describe the net change in one variable over an interval of another. This allows students to understand change in a variety of contexts.

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.
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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 is an instantaneous rate of change useful?
- How can a derivative be interpreted?
- How can we use derivatives to understand the behavior of functions?

Unit Enduring Understandings:

- A derivative is the instantaneous rate of change of a function.
- Derivatives can be used to identify key features of a function and its graph.
- Derivative concepts help explain phenomena in the physical world by examining them in multiple representations.

Vocabulary: derivative, differentiate, instantaneous, implicit, explicit, related rate, linearization, extrema, optimization

Students will be able to:

- Apply the definition of derivative as a function.
- Interpret the derivative as a rate of change and find the average & instantaneous rate of change.
- Apply the power rule, product rule, quotient rule, and chain rule to evaluate derivatives of functions.
- Differentiate polynomial, rational, trigonometric, exponential, logarithmic, inverse trigonometric, and radical functions.
- Apply the method of implicit differentiation.
- Evaluate the derivative of an inverse function at a given point.
- Apply the method of logarithmic differentiation.
- Evaluate higher order derivatives.
- Solve related rate applications.
- Find the linearization of a function and use it to approximate values.
- Apply calculus to find the relative and absolute extrema of a function.
- Apply L'Hospital's rule in evaluating limits.
- Apply the Mean Value Theorem.
- Apply the Extreme Value Theorem.
- Analyze and make connections between a function and its derivative graphically.
- Connect and interpret position, velocity, and acceleration using derivatives for 1-dimensional motion.
- Solve real world optimization problems.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities
    - Lock Box Derivative Rules Activity

- Derivative Rules Jeopardy
- L'Hopital's Rule Card Sort Activity
- Collegeboard Functional Analysis Cards Activity

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

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Students at Risk of Failure

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-Enrichment/Extension Activities within Digital Platforms such as Deltamath

Unit 3

Desired Results

Unit 3: Integration

Unit Summary: Along with limits and differentiation, integration is a fundamental operation of calculus. This unit features a multi-representational approach to calculus, with integrals and their related theorems expressed graphically, numerically, analytically, and verbally. Exploring connections among these representations builds understanding to solve problems in mathematics and physics involving the area of an arbitrary shape, the length of a curve, and the volume of a solid, among others.

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.
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Interdisciplinary Connections

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

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- 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:
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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 estimation techniques and limits used to develop the idea of an infinite sum?
- How can an integral be interpreted?
- How are derivatives and integrals related?
- How can we use integrals to understand the behavior of functions?

Unit Enduring Understandings:

- Integral calculus allows for the derivation of length, area, and volume of function-defined objects through infinite sums.
- Integral concepts help explain phenomena in the physical world across different fields by examining them in multiple representations.
- Integrals are connected to derivatives through the Fundamental Theorem of Calculus.

Vocabulary: antiderivative, integral, integrate, Riemann Sum, definite integral, indefinite integral, partial fraction decomposition, improper integral, convergent, divergent, arc length, slope field, solution curve, initial condition, differential equation, logistic model

Students will be able to:

- Determine the antiderivative of a function.
- Approximate definite integrals using Riemann sums or Trapezoidal sums.
- Approximate the displacement or total distance traveled by a particle moving along a line.
- Apply the Fundamental Theorem of Calculus to evaluate definite integrals and take derivatives of integrals.
- Solve applications involving the Total Change Theorem.
- Evaluate definite and indefinite integrals by applying the substitution rule, integration by parts, and partial fraction decomposition.
- Use limit notation to evaluate convergent and divergent improper integrals.
- Determine the average value of a function.
- Find the area of a region bounded by two curves.
- Find the volume of a solid obtained by a rotation, using the disk and/or washer method.
- Find the volume of a solid with known cross-sections.
- Find the length of an arc
- Solve application problems involving length, area, and volume.
- Construct a slope field and sketch a solution curve according to an initial condition.
- Solve a differential equation by using separation of variables.
- Analyze exponential growth and decay examples, including logistic models.
- Approximate the value of a function using Euler's method.
- Match equations and differential equations with slope fields and solution curves.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities
    - Basic Integration Rules Stations Activity
    - I have, who has Matching Activity
    - X-Factor Integral Card Activity
    - Improper Integral Maze
    - Area/Volume Sidewalk Chalk
    - Area/Volume Find the Error
    - Slope Field Matching Activity
    - Euler's Method Jigsaw Activity

Assessment Evidence

Formative Assessments:

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

Summative Assessments:

- Cumulative Assessments

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- AP Classroom Progress Checks

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-Enrichment/Extension Activities within Digital Platforms such as Deltamath

Unit 4

Desired Results

Unit 4: Parametric and Polar Equations

Unit Summary:

In addition to rectangular form, equations and graphs can be represented using parametric and polar functions. In this unit, students will learn to convert between these representations and apply their knowledge of calculus in the cartesian system to the polar system. This unit features a multi-representational approach to polar calculus and two dimensional motion expressed graphically, numerically, analytically, and verbally. Exploring connections among these representations builds understanding to solve problems in mathematics and physics involving the equation of tangent lines, the area of an arbitrary shape, and the motion along a curve, among others.

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)
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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.
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  - 2.A Identify common underlying structures in problems involving different contextual situations.
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- 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.

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  - 3.C Confirm whether hypotheses or conditions of a selected definition, theorem, or test have been satisfied.
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  - 3.F Explain the meaning of mathematical solutions in context.
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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).
  - 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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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:
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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 would it be useful to represent curves in different coordinate systems?
- How do you use vectors to describe motion in two dimensions?
- What are the similarities and differences in interpreting derivatives of rectangular, parametric, and polar curves?

Unit Enduring Understandings:

- Calculus can be represented in multiple coordinate systems and each one has a particular advantage.
- Calculus can be applied to all plane curves, even when not interpreted as a function y in terms of x.
- Concepts in polar and parametric systems offer an alternative approach to explaining phenomena in the physical world by examining them in multiple representations.

Vocabulary: parametric equation, polar equation, position, velocity, acceleration, speed, arc length, total distance, slope, concavity	
Students will be able to: • Find an equation of a tangent line at a point on a polar or parametric curve. • Find the area of a region bounded by the graphs of polar equations. • Determine the position, velocity, and/or acceleration vectors in 2D motion problems. • Determine the speed of an object moving in a 2D plane. • Find the distance traveled, or arc length, along a plane curve. • Interpret the motion of a particle whose movement is defined by polar or parametric equations. • The slope of the tangent line represented by dy/dx is the ratio of the derivatives of y(t) and x(t). • Find the second derivative of a parametrically defined curve and use it to interpret concavity.	
Learning Activities: • Small Group • Differentiation - Enrichment, Support, etc.	

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

- Math Ixl
- 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

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
-Enrichment/Extension Activities within Digital Platforms such as Deltamath

Unit 5

Desired Results

Unit 5: Infinite Series

Unit Summary: Polynomials are much simpler to work with in many mathematical contexts than other types of functions. In this unit, students will learn how to use calculus to create polynomials that approximate various functions. Students will also learn different ways of assessing the accuracy of their approximations and, for infinite polynomials, determine the convergence and divergence of those infinite series. Using the tests of convergence and divergence, students will learn to identify the interval of convergence for these infinite series representations. This unit features a multi-representational approach to calculus, with series expressed numerically, graphically, analytically, and verbally. Exploring connections among these representations builds understanding to solve problems in mathematics.

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.
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  - 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)*:

- 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:
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Learning Targets

Unit Essential Questions:	**Unit Enduring Understandings:**
• Why can functions be represented as infinite series and how does this representation benefit us as students of calculus?	• Infinite series help to simplify computations and perform calculus on different functions.

• How can you identify the best test of convergence or divergence for a given infinite series?	• Different tests are required to determine the convergence or divergence of an infinite series due to the unique characteristics of each series.

Vocabulary: sequence, series, general term, harmonic series, p-series, alternating series, geometric series, interval of convergence, absolutely convergent, conditionally convergent, Taylor series, Taylor polynomial, Maclaurin Series

Students will be able to:

- Determine if a sequence converges or diverges.
- Find the general term of a sequence.
- Apply the ratio, integral, nth term, alternating series, limit comparison, and direct comparison tests.
- Analyze different types of series including geometric, harmonic, p-series, alternating, and more.
- Determine whether an infinite series converges or diverges.
- Find the interval of convergence of a power series.
- Determine the sum of a convergent infinite geometric series.
- Determine if a convergent infinite series is either absolutely convergent or conditionally convergent.
- Define a function using a power series.
- Write the Taylor or Maclaurin series for a provided function.
- Approximate the value of a function using a Taylor polynomial.
- Determine the error bound for Taylor polynomial approximations.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Suggested Activities
    - Series Go-Fish Card Game

- Series Foldable
- Taylor and Maclaurin Series Card Sort

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

- Math Ixl
- Deltamath
- Khan Academy
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Specific Strategies and Practices that Support Students with Disabilities:

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Unit 6

Desired Results

Unit 6: 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)
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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:

- Common Unit Projects

Alternative Assessments:

- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Google Platform
- AP Classroom

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