

Summit Public Schools
Summit, New Jersey
Grade Level 12 / Content Area: Mathematics
Length of Course: Full Year

Calculus Curriculum
 (Angelique Bender 2023)

Course Description: Topics learned in Pre-Calculus will be solidified and extended to reveal their connections to Calculus. The main objective of the course is to explore the concepts of, and connection between limits, derivatives and integrals, with an emphasis on real-world applications in the sciences, business, and economics.

Pacing Guide

Unit P – Preparing for Calculus

Topic	Time Frame
P1 Functions and Their Graphs	1
P2 Library of Functions: Mathematical Modeling	1
P3 Operations on Functions: Graphing Techniques	2
P4 Inverse Functions	1
P5 Exponential and Logarithmic Functions	2
P6 Trigonometric Functions	2
P7 Inverse Trigonometric Functions	2
Test Unit P	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	3
Total	15 Days

Unit 1 - Limits and Continuity

Topic	Time Frame
1.1 Limits of Functions Using Numerical and Graphical Techniques	1.5
1.2 Analytic Techniques for Finding Limits of Functions	2.5
1.3 Continuity	2
Quiz	
1.4 Limits and Continuity of Trigonometric, Exponential and Logarithmic Functions	2
1.5 Infinite Limits, Limits at Infinity, Asymptotes	2
Test Unit 1	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	3
Total	14

Unit 2 – The Derivative and Its Properties

Topic	Time Frame
2.1 Rates of Change and the Derivative	1.5
2.2 The Derivative as a Function, Differentiability	2.5
2.3 The Derivative of a Polynomial Function, The Derivative of $y = e^x$	2
Quiz	1

2.4 Differentiating the Product and the Quotient of Two Functions, Higher Order Derivatives	2
2.5 The Derivative of Trigonometric Functions	2
Test Unit 2	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	3
Total	15 Days

Unit 3 – The Derivative of Composite, Implicit and Inverse Rules

Topic	Time Frame
3.1 The Chain Rule	3
3.2 Implicit Differentiation	2
Quiz	1
3.3 The Derivative of Inverse Trigonometric Functions	3
3.4 Derivatives of Logarithmic Functions Implicit Functions	2
4.3 Related Rates	3
Unit Test	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	3
Total	Days
	18 days

-MIDTERM-midterm review

3 days

Unit 4 – Applications of the Derivative, Part 1

Topic	Time Frame
4.1 Interpreting a Derivative	2
4.2 Linear Approximation	2
Quiz	1
4.4 Indeterminate Forms and L'Hopital's Rule	2
Unit Test	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	2
Total	10 days

Unit 5 – Applications of the Derivative, Part 2

Topic	Time Frame
5.1 Maximum and Minimum Values; Critical Numbers	2
5.2 Mean Value Theorem	2
5.3 Local Extrema and Concavity	2
Quiz	1
5.4 Using Calculus to Graph Functions	2
5.5 Optimization	3
Unit Test	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	2
Total	15 days

Unit 6 – Introduction to Integrals

Topic	Time Frame
5.6 Antiderivatives and Differential Equations	2
6.1 Area	2
6.2 /6.11 The Definite Integral / Riemann Sums including midpoint and trapezoidal sums	2
Quiz	1
6.3 Fundamental Theorem of Calculus (part 2)	3
6.4 Properties of the Definite Integral	2
Unit Test	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	2
Total	15 days

Unit 7 – Integration Techniques/Applications of Integration

Topic	Time Frame
6.3 The Fundamental Theorem of Calculus (part 1)	2
6.5 The Indefinite Integral / u-substitution	3
Quiz	1
8.1 Area between Graphs	3
8.4 Volume of a Solid by Slicing	2
8.2 Volume of a Solid of Revolutions: Disks and Washers	3
8.3 (time permitting) Volume of a Solid of Revolutions: Shell Method	
Unit Test	1
Misc. Quizzes / Test Review / Extension time for any section (if needed)	2
Total	17 days

-FINAL review / Final Exam - 3 days

Unit P: Functions/Continuity/Limits The connectedness / features of linear, quadratic, exponential, logarithmic, rational, and trigonometric functions form the foundation of Calculus	
Big Ideas: • Functions can be represented in different ways • Students will learn and review essential skills to prepare them to learn about the concepts and principles of calculus	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i>	Enduring Understandings <i>What will students understand about the big ideas?</i>
• What do the characteristics of a function tell us about the behavior of the graph of that function? • How can new functions be made from old, and what changes when that happens?	• Modeling real-world data with functions can help predict future behavior • Algebraic operations can be applied to functions (including the composition of functions).

Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will: - Find domain, range, compositions and inverses of functions - Sketch graphs by applying transformations to the parent function - Analyze the properties of linear, quadratic, exponential, logarithmic, rational and trigonometric functions. - Use graphing technologies (TI-83+ and Desmos online calculator, Geogebra, Wolfram Alpha) to assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions. Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	Instructional Focus: - P.1 Functions and their graphs - P.2 Library of functions - P.3 Operations on functions; graphing techniques - P.5 Exponential and Logarithmic functions - P.6/7 Trigonometric and Inverse Trigonometric functions Sample Assessments: - Classwork and homework - Exit tickets/warm-ups/short quizzes - Long quizzes - Unit exam Instructional Strategies: Interdisciplinary Connections - Half-life calculations using logarithms and exponential functions (Science) - Modeling supply and demand for products, finding break even points (Business, Economics, Finance) Technology Integration - Desmos, Geogebra, Wolfram Alpha will assist in the discovery of characteristics of functions. Global Perspectives/ Culturally Responsive Teaching - Population studies from various countries using exponential functions
The following skills and themes listed to the right should be reflected in the design of units and lessons for this course or content area.	21st Century Skills: Creativity and Innovation Critical Thinking and Problem Solving Communication and Collaboration Information Literacy Media Literacy Life and Career Skills 21st Century Themes (as applies to content area):

	Financial, Economic, Business, and Entrepreneurial Literacy Civic Literacy Health Literacy S.T.E.A.M. (Science, Technology, Engineering, Arts, Mathematics)																																																				
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Unit 1: Continuity/Limits The connectedness between linear, quadratic, exponential, logarithmic, rational, and trigonometric functions form the foundation for the conceptual understanding of continuity and limits. Big Ideas: - Continuity leads to the concept of a limit - Limits form the foundation of differential calculus	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i> What does it mean to be continuous? What factors cause a function to be discontinuous?	Enduring Understandings <i>What will students understand about the big ideas?</i> - Exponential functions dominate power and linear functions - A continuous function has a graph that can be drawn without lifting the pencil from the paper.

• What is <i>infinitesimal</i> and how does this concept relate to continuity and limits? • What does the limit of a function at certain values tell us about the asymptotes of the graph of that function? • What is a limit and how does it help us in other areas of Calculus?	• Continuity can be examined from a graph or table. • There are left-sided and right-sided limits. Sometimes, a limit does not exist. • If the limit as x approaches a value is not the same as evaluating the function for the same value, the function is discontinuous at that value. • Dividing by zero can lead to two different types of discontinuities. A function must be completely simplified before deciding. • A vertical asymptote is a type of discontinuity that can occur in the graph of a function • A horizontal asymptote occurs when the limit as x goes to infinity and/or negative infinity approaches a finite number.
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments

Students will:	Instructional Focus:
• Find domain, range, compositions and inverses of functions	• 1.1 Numerical and Graphical Limits
• Sketch graphs by applying transformations to the parent function	• 1.2 Analytic Techniques for Finding Limits
• Analyze the properties of linear, quadratic, exponential, logarithmic, rational and trigonometric functions.	• 1.3 Continuity
• Use graphing technologies (TI-83+ and Desmos online calculator, Geogebra, Wolfram Alpha) to assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions.	• 1.4 Limits and Continuity of Trigonometric, Exponential and Logarithmic Functions
• Locate and determine the types of discontinuities graphically, algebraically, and by examining tables	• 1.5 Trigonometric functions
• Find limits graphically, algebraically and by examining tables.	• Infinite Limits; Limits at Infinity, Asymptotes
	Sample Assessments:
	• Classwork and homework • Exit tickets/warm-ups/short quizzes • Long quizzes • Unit exam
	Instructional Strategies:

● Use limit notation Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	Technology Integration ● Desmos, Geogebra, Wolfram Alpha will assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions.
The following skills and themes listed to the right should be reflected in the design of units and lessons for this course or content area.	21st Century Skills: - Creativity and Innovation - Critical Thinking and Problem Solving - Communication and Collaboration - Information Literacy - Media Literacy - Life and Career Skills 21st Century Themes (as applies to content area): - Financial, Economic, Business, and Entrepreneurial Literacy - Civic Literacy - Health Literacy - S.T.E.A.M. (Science, Technology, Engineering, Arts, Mathematics)
Differentiation	

Supports for English Language Learners			Intervention Strategies		
Sensory Supports	Graphic Supports	Interactive Supports	Accommodations	Interventions	Modifications
Real-life objects	Charts	In pairs or partners	Allow for verbal responses	Multi-sensory techniques	Modified tasks/expectations
Manipulatives	Graphic Organizers	In triads or small groups	Repeat/confirm directions	Increase task structure (e.g. directions, checks for understanding, feedback)	Differentiated materials
Pictures	Tables	In a whole group	Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding	Individualized assessment tools based on student need
Illustrations, diagrams & drawings	Graphs	Using cooperative group	Audio Books	Utilize pre-reading strategies and activities previews, anticipatory guides, and semantic mapping	Modified assessment grading
Magazines & Newspapers	Timelines	Structures			
Physical activities	Number lines	Internet / Software support			
Videos & Film		In the home language			
Broadcasts		With mentors			
Models & Figures					

Unit 2: Introduction to Derivatives	
Real-world average and instantaneous velocity examples are studied numerically, algebraically and graphically, all leading to the definition of a derivative and requirements for differentiability.	
Big Ideas: - Calculus is the study of change - Derivatives help us understand events in the sciences and economics.	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i>	Enduring Understandings <i>What will students understand about the big ideas?</i>
- How is speed measured? How is it different than velocity? - What is the difference between average velocity and instantaneous velocity? - How are average velocity and instantaneous velocity represented graphically? - How is the slope of a line used to find the derivative of any curve at a point?	- Average velocity of an object over an interval is the net change in position during the interval divided by the change in time - Instantaneous velocity of an object at a specific time is the limit of the average velocity over an interval, as the interval shrinks around the specific time - Linear functions help us find the instantaneous velocity. The instantaneous velocity is the slope of a curve at a point

• Can we find the derivative of an entire function at once, or only one point at a time? • What does the graph of the derivative function look like? • How can derivatives be found from a graph, table of values, or formula? • How do we represent derivatives and what units do we place on them? • What does it mean to be differentiable? • What is the difference quotient and how does it relate to the concept of a limit?	• If the derivative is positive on an interval, the curve is increasing over that interval, and if the derivative is negative on an interval, the curve is decreasing over that interval • The derivative of a line is the slope of that line • The derivative of a constant is zero • Functions are not differentiable at vertical tangents, sharp corners, or any discontinuity. • dy/dx and f' are common and acceptable ways to represent the derivative
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will:	Instructional Focus:
• Calculate average velocity using real-world data from tables, graph, and functions	• 2.1 Rates of Change and the Derivative • 2.2 The Derivative as a Function; Differentiability • 2.3 The Derivative of a Polynomial and e^x • 2.4 Product and Quotient Rule; Higher Order Derivatives • 2.5 The Derivative of Trigonometric Functions
• Given a function f, sketch the derivative graph f'	
• Estimate instantaneous velocity at a point using information from tables and graphs	
• Use the definition of a derivative to calculate instantaneous velocity at a point	
• Use the definition of a derivative to find a derivative function	Sample Assessments:
• Sketch graphs based on properties (i.e. Sketch f given that on the interval $0 < x < 4$, $f' > 0$ on all other intervals $f' < 0$)	• Classwork and homework • Exit tickets/warm-ups/short quizzes • Long quizzes

● Interpret statements and scenarios using derivative notation Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	● Unit exam Summative assessments/projects that encompass all skills learned in this unit can be found on page 161 in the text. These assessments can be given independently or as a group, and include 21st century themes and skills and higher-order thinking to complete. Instructional Strategies: Interdisciplinary Connections ● Interpreting rate of change of chemical reactions, temperature (science), interest and principal values in bank accounts (business/finance) Technology Integration ● Desmos, Geogebra, Wolfram Alpha will assist in the discovery and identification of derivatives Global Perspectives/ Culturally Responsive Teaching ● Interpreting rate of change of population, birth rates, earthquakes and bodies of water around the world
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Differentiation	

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Manipulatives	Graphic Organizers	In triads or small groups	Repeat/confirm directions	Increase task structure (e.g. directions, checks for understanding, feedback)	Differentiated materials
Pictures	Tables	In a whole group	Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding	Individualized assessment tools based on student need
Illustrations, diagrams & drawings	Graphs	Using cooperative group	Audio Books	Utilize pre-reading strategies and activities previews, anticipatory guides, and semantic mapping	Modified assessment grading
Magazines & Newspapers	Timelines	Structures			
Physical activities	Number lines	Internet / Software support			
Videos & Film		In the home language			
Broadcasts		With mentors			
Models & Figures					

Unit 3: Derivative Rules	
Derivative rules are examined and applied using examples that develop students' intuition behind them.	
Big Ideas: - Calculus is the study of change - Derivatives help us understand events in the natural sciences and economics.	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i>	Enduring Understandings <i>What will students understand about the big ideas?</i>
- How are derivatives connected to the functions studied in Unit 1? - Does applying algebraic operations to functions change the derivative of a function? - Is using the definition of a derivative the only way to calculate a derivative? - What is an implicit function and how do you find the derivative of an implicit function? - Can you take the derivative of a derivative? When does it stop?	- Taking the derivative of a constant multiplied by a function is the same as taking the derivative of that function and then multiplying by the constant $[d/dx [cf(x)]] = c f'(x)$ $d/dx [f(x) \pm g(x)] = f'(x) \pm g'(x)$ - The derivative function is used to find the slope of the tangent line of a function at any point - The derivative at a point tells us the rate of change at that exact point. This helps us solve problems in across all interdisciplinary fields - A family of functions can all have the same derivative (e.g. all functions of

	the form $y=2x + k$ where k is a constant have a derivative of 2) • An implicit function is one in which one variable cannot be expressed explicitly in terms of the other. • In many real-world scenarios, multiple rates are changing at the same time. For example, how fast is the volume of a melting snowball changing at the moment the radius is 20cm and decreasing at 3cm/min?
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will:	• 3.1 The Chain Rule • 3.2 Implicit Differentiation • 3.3 The Derivative of Inverse Trigonometric Functions • 3.4 Derivatives of Logarithmic Functions Implicit Functions • 4.3 Related Rates Sample Assessments: • Classwork and homework • Exit tickets/warm-ups/short quizzes • Long quizzes • Unit exam Instructional Strategies:
• Use the Mean Value Theorem and Rolle's Theorem to find values on specific intervals where the instantaneous rate of change is equal to the average rate of change. Create a function over an interval that does not satisfy the hypothesis of the MVT.	
• Use the first and second derivative tests to locate critical values and to answer questions about optimization	
• Find intervals of increase and decrease, and where a function is concave up or down.	

● Fuse geometric applications and formulas with calculus to solve problems involving related rates Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	Technology Integration ● Desmos, Geogebra, Wolfram Alpha will assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions.
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Magazines & Newspapers	Timelines	Structures			
Physical activities	Number lines	Internet / Software support			
Videos & Film		In the home language			
Broadcasts		With mentors			
Models & Figures					

Unit 4: Applications of the Derivative, Part 1	
Concepts learned in Standard 2 and 3 are extended to incorporate a real-world application, optimization. The Mean Value Theorem and linearization are also examined. As a culminating activity, a weeklong economics-driven group project cements the concepts presented.	
Big Ideas: - Calculus is the study of change - Derivatives help us understand events in the natural sciences and economics.	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i>	Enduring Understandings <i>What will students understand about the big ideas?</i>
- How are average and instantaneous velocity connected? - How does differentiability make a graph look straight when it is zoomed in at a point? - How do derivatives help solve real-world problems?	- The Mean Value Theorem provides a way to show that if f is continuous on some interval, there is some number "c" such that the instantaneous rate of change at "c" is the same as the average rate of change on that interval (i.e. the slope of tangent and secant line are the same under these conditions) - Using the first and second derivative tests locate values of interest on functions that model real-world data. Local and global extrema and other

	behaviors are revealed from these tests. • L'Hopital's rule provides a way to deal with limits.
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will: • Use local linearization to find a tangent line approximation for functions near specific values • Use the first and second derivative tests to locate critical values and to answer questions about optimization • Find intervals of increase and decrease, and where a function is concave up or down. Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	• 4.1 Interpreting a Derivative • 4.2 Linear Approximation • 4.4 Indeterminate Forms and L'Hopital's Rule Sample Assessments: • Classwork and homework • Exit tickets/warm-ups/short quizzes • Long quizzes • Unit exam Instructional Strategies: Technology Integration • Desmos, Geogebra, Wolfram Alpha will assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions.
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			Health Literacy S.T.E.A.M. (Science, Technology, Engineering, Arts, Mathematics)		
Differentiation					
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Magazines & Newspapers	Timelines	Structures			
Physical activities	Number lines	Internet / Software support	Audio Books	Utilize pre-reading strategies and activities previews, anticipatory guides, and semantic mapping	Modified assessment grading
Videos & Film		In the home language			
Broadcasts		With mentors			
Models & Figures					

Unit 5: Applications of the Derivative, Part 2 Concepts learned in Standard 2 and 3 are extended to incorporate a real-world application, optimization. The Mean Value Theorem and linearization are also examined. As a culminating activity, a weeklong economics-driven group project cements the concepts presented.	
Big Ideas: - Calculus is the study of change - Derivatives help us understand events in the natural sciences and economics.	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i>	Enduring Understandings <i>What will students understand about the big ideas?</i>
- How are average and instantaneous velocity connected? - How does differentiability make a graph look straight when it is zoomed in at a point? - How do derivatives help solve real-world problems?	The Mean Value Theorem provides a way to show that if f is continuous on some interval, there is some number "c" such that the instantaneous rate of change at "c" is the same as the average rate of change on that interval (i.e. the slope

	of tangent and secant line are the same under these conditions) Using the first and second derivative tests locate values of interest on functions that model real-world data. Local and global extrema and other behaviors are revealed from these tests.
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will:	
Use the Mean Value Theorem and Rolle's Theorem to find values on specific intervals where the instantaneous rate of change is equal to the average rate of change. Create a function over an interval that does not satisfy the hypothesis of the MVT.	5.1 Maximum and Minimum Values; Critical Numbers 5.2 Mean Value Theorem 5.3 Local Extrema and Concavity 5.4 Using Calculus to Graph Functions 5.5 Optimization
Use the first and second derivative tests to locate critical values and to answer questions about optimization	Sample Assessments: - Classwork and homework - Exit tickets/warm-ups/short quizzes - Long quizzes - Unit exam
Find intervals of increase and decrease, and where a function is concave up or down. Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	Instructional Strategies: Technology Integration Desmos, Geogebra, Wolfram Alpha will assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions.
The following skills and themes listed to the right should be reflected in the design of	21st Century Skills: Creativity and Innovation

units and lessons for this course or content area.	Critical Thinking and Problem Solving Communication and Collaboration Information Literacy Media Literacy Life and Career Skills 21st Century Themes (as applies to content area): Financial, Economic, Business, and Entrepreneurial Literacy Civic Literacy Health Literacy S.T.E.A.M. (Science, Technology, Engineering, Arts, Mathematics)
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Differentiation					
Supports for English Language Learners			Intervention Strategies		
Sensory Supports	Graphic Supports	Interactive Supports	Accommodations	Interventions	Modifications
Real-life objects	Charts	In pairs or partners	Allow for verbal responses	Multi-sensory techniques	Modified tasks/expectations
Manipulatives	Graphic Organizers	In triads or small groups	Repeat/confirm directions	Increase task structure (e.g. directions, checks for understanding, feedback)	Differentiated materials
Pictures	Tables	In a whole group			
Illustrations, diagrams & drawings	Graphs	Using cooperative group	Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding	Individualized assessment tools based on student need
Magazines & Newspapers	Timelines	Structures			
Physical activities	Number lines	Internet / Software support	Audio Books	Utilize pre-reading strategies and activities previews, anticipatory guides, and semantic mapping	Modified assessment grading
Videos & Film		In the home language			
Broadcasts		With mentors			
Models & Figures					

Unit 6: Introduction to Integrals	
Real-world examples are studied numerically, algebraically and graphically, to develop students' intuition behind what definite and indefinite integrals are how and they are used.	
Big Ideas: - Calculus is the study of change - Integrals help us understand events in the natural sciences and economics.	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i>	Enduring Understandings <i>What will students understand about the big ideas?</i>

• How do we measure distance traveled? • What is a Riemann sum and how does combining it with the concept of a limit help us solve problems? • What is a definite integral and how does it relate to other areas of calculus? • How are indefinite integrals related to derivatives?	• The area underneath a curve can be approximated by summing up the area of rectangles of varying bases and heights that go from the x-axis to the function itself. • Some estimates using rectangles are over estimates and some are under estimates. Calculus will show how to determine this. • To get an exact area, the width of the rectangles used underneath the curve should go to zero (concept of a limit, unit 1) • The area underneath a velocity curve represents distance traveled • Area under the x-axis counts negatively and area above the x-axis counts positively.
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	Examples, Outcomes, Assessments
Students will:	• 5.6 Antiderivatives and Differential Equations • 6.1 Area • 6.2 /6.11 The Definite Integral / Riemann Sums including midpoint and trapezoidal sums • 6.3 Fundamental Theorem of Calculus (part 2) • 6.4 Properties of the Definite Integral
• Estimate distance traveled given tables and graphs by calculating left and right endpoint sums as well as trapezoid and midpoint calculations	
• Find the area under a curve of a familiar shape (semi-circles, rectangles, triangles, trapezoids, etc)	
• Use and interpret definite integral notation (upper and lower limits of integration, integrand)	

Count areas above the x-axis as positive and areas below the x-axis as negative Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	Sample Assessments: - Classwork and homework - Exit tickets/warm-ups/short quizzes - Long quizzes - Unit exam Instructional Strategies: Technology Integration - Desmos, Geogebra, Wolfram Alpha will assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions.
The following skills and themes listed to the right should be reflected in the design of units and lessons for this course or content area.	21st Century Skills: Creativity and Innovation Critical Thinking and Problem Solving Communication and Collaboration Information Literacy Media Literacy Life and Career Skills 21st Century Themes (as applies to content area): Financial, Economic, Business, and Entrepreneurial Literacy Civic Literacy Health Literacy S.T.E.A.M. (Science, Technology, Engineering, Arts, Mathematics)
Differentiation	

Supports for English Language Learners			Intervention Strategies		
Sensory Supports	Graphic Supports	Interactive Supports	Accommodations	Interventions	Modifications
Real-life objects	Charts	In pairs or partners	Allow for verbal responses	Multi-sensory techniques	Modified tasks/expectations
Manipulatives	Graphic Organizers	In triads or small groups	Repeat/confirm directions	Increase task structure (e.g. directions, checks for understanding, feedback)	Differentiated materials
Pictures	Tables	In a whole group	Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding	Individualized assessment tools based on student need
Illustrations, diagrams & drawings	Graphs	Using cooperative group	Audio Books	Utilize pre-reading strategies and activities previews, anticipatory guides, and semantic mapping	Modified assessment grading
Magazines & Newspapers	Timelines	Structures			
Physical activities	Number lines	Internet / Software support			
Videos & Film		In the home language			
Broadcasts		With mentors			
Models & Figures					

Unit 7: Integration Techniques/Applications of Integration	
The Fundamental Theorem of Calculus (both parts) and its applications are studied in depth. Methods of integration (including integration by substitution) are introduced both with and without a calculator. The unit culminates with applications of integration.	
Big Ideas: - Calculus is the study of change - Integrals help us understand events in the natural sciences and economics.	
Essential Questions <i>What provocative questions will foster inquiry, understanding, and transfer of learning?</i>	Enduring Understandings <i>What will students understand about the big ideas?</i>
- What is the importance of the Fundamental Theorem of Calculus (both parts)? - How does the concept of a differential equation tie into themes learned throughout calculus? - How can integration be used to solve geometry problems?	- The Fundamental Theorems of Calculus define the inverse relationship between the derivative and integral, as well as provide a method for computing a definite integral using antiderivatives. - The initial condition of a differential equation helps us pick the particular solution to the equation. - Washers, disks, and shells can be used to find the area of geometric figures, both two and three dimensional.
Areas of Focus: Proficiencies	Examples, Outcomes, Assessments

(Cumulative Progress Indicators)	
Students will:	6.3 The Fundamental Theorem of Calculus (part 1) 6.5 The Indefinite Integral / u-substitution 8.1 Area between Graphs 8.4 Volume of a Solid by Slicing 8.2 Volume of a Solid of Revolutions: Disks and Washers 8.3 (time permitting) Volume of a Solid of Revolutions: Shell Method
Use the FTC1 to evaluate definite integrals without a calculator	Sample Assessments: - Classwork and homework - Exit tickets/warm-ups/short quizzes - Long quizzes - Unit exam Instructional Strategies: Technology Integration - Desmos, Geogebra, Wolfram Alpha will assist in the discovery and identification of limits, discontinuities, end behavior, and other unique characteristics of functions.
Use the FTC2 to evaluate definite integrals where the upper limit of integration is a function	
Use differential equations and initial conditions to answer questions about position, velocity and acceleration of objects	
Evaluate definite integrals where the integrand has an “inner” function (by substitution)	
Find the area between curves and the x-axis and y-axis, and between two functions	
Find the volume of solids formed by rotating areas around specific axes. Career-Ready Practices CRP1: Act as a responsible and contributing citizen and employee. CRP2: Apply appropriate academic and technical skills. CRP3: Attend to personal health and financial well-being. CRP4: Communicate clearly and effectively and with reason. CRP5: Consider the environmental, social and economic impacts of decisions. CRP6: Demonstrate creativity and innovation. CRP7: Employ valid and reliable research strategies. CRP8: Utilize critical thinking to make sense of problems and persevere in solving them. CRP9: Model integrity, ethical leadership and effective management. CRP10: Plan education and career paths aligned to personal goals. CRP11: Use technology to enhance productivity. CRP12: Work productively in teams while using cultural global competence.	
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	Entrepreneurial Literacy Civic Literacy Health Literacy S.T.E.A.M. (Science, Technology, Engineering, Arts, Mathematics)				
Differentiation					
Supports for English Language Learners			Intervention Strategies		
Sensory Supports	Graphic Supports	Interactive Supports	Accommodations	Interventions	Modifications
Real-life objects	Charts	In pairs or partners	Allow for verbal responses	Multi-sensory techniques	Modified tasks/expectations
Manipulatives	Graphic Organizers	In triands or small groups	Repeat/confirm directions	Increase task structure (e.g. directions, checks for understanding, feedback	Differentiated materials
Pictures	Tables	In a whole group			
Illustrations, diagrams & drawings	Graphs	Using cooperative group	Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding	Individualized assessment tools based on student need
Magazines & Newspapers	Timelines	Structures			
Physical activities	Number lines	Internet / Software support	Audio Books	Utilize pre-reading strategies and activities previews, anticipatory guides, and semantic mapping	Modified assessment grading
Videos & Film		In the home language			
Broadcasts		With mentors			
Models & Figures					

Texts and Resources:

Sullivan Miranda, Calculus for the AP course 3rd ed. W. H. Freeman and Co, 2020.