

Rumson-Fair Haven Regional High School

Course: *AP Calculus BC*

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Section I: Course Description

AP Calculus BC is primarily concerned with developing the students' understanding of the concepts of calculus and providing experiences with its methods and applications. The course emphasizes a multi-representational approach to calculus, with concepts, results, and problems being expressed graphically, numerically, analytically (algebraically), and verbally. The connections among these representations are also important. Broad concepts and widely applicable methods are emphasized. The focus of the course is neither manipulation nor memorization of an extensive taxonomy of functions, curves, theorems, or problems types. Although facility with manipulation and computational competence are important outcomes, they are not the core of this course. Technology will be used regularly by students to reinforce the relationships among multiple representations of functions, to confirm written work, to implement experimentation, and to assist in interpreting results. Through the use of the unifying themes of derivatives, integrals, limits, approximation, and applications and modeling, the course becomes a cohesive whole rather than a collection of unrelated topics. These themes are developed using the following functions: linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric, and piece-wise defined.

Section II: NJSLs: New Jersey Student Learning Standards/Learning Objectives:

1. **2023 New Jersey Student Learning Standards – Mathematics:**
 - “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; ...A high-quality mathematics education 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.”
2. **2023 New Jersey Student Learning Standards English Language Arts:**
 - A New Jersey education in English Language Arts builds readers, writers, and communicators prepared to meet the demands of college and career and to engage as productive American citizens with global responsibilities. ...Students will develop the necessary skills in reading, writing, speaking, and listening that are the foundations for creative and purposeful expression in language read rich, challenging texts that build their knowledge of the world, grow their confidence and identities as readers, and develop critical thinking skills and vocabulary necessary for long-term success[; e]ngage in regular, meaningful, writing authentic tasks, exploring valued topics, writing for impact and expression, and sharing their work with others (including authentic audiences) leverage complex texts and digital media to develop comprehension, active listening, and discussion skills ground daily writing and discussion in evidence, fostering an ability to read critically, build arguments, cite evidence, and communicate ideas to contribute meaningfully as productive citizens evaluate the reliability, credibility, and perspective of authors and speakers across all forms of media express ideas and knowledge through a variety of modalities and media, and serve as effective communicators who purposefully read, write, and speak across multiple disciplines [and l]earn to persist in reading complex texts, establishing lifelong habits to read voluntarily for pleasure, for further education, for information on public policy, and for advancement in the workplace.
3. **2020 New Jersey Student Learning Standards – Science:**
 - “Scientific and technological advances have proliferated and now permeate most aspects of life in the 21st century. It is increasingly important that all members of our society develop an understanding of scientific and engineering concepts and processes. Learning how to construct scientific explanations and how to design evidence-based solutions provides students with tools to think critically about personal and societal issues and needs. Students can then contribute meaningfully to decision-making processes, such as discussions about climate change, new approaches to health care, and innovative solutions to local and global problems.”
4. **Standard 8.1 (Computer Science) and 8.2 (Design Thinking) of the 2020 NJSLs:**
 - “The ‘Intent and Spirit of the Computer Science and Design Thinking Standards’ is to focus on deep understanding of concepts that enable students to think critically and systematically about leveraging technology to solve local and global issues. Authentic learning experiences that enable students to apply content knowledge, integrate concepts across disciplines, develop computational thinking skills, acquire

and incorporate varied perspectives, and communicate with diverse audiences about the use and effects of computing prepares New Jersey students for college and careers.”

5. **Standard 9.4 (Life Literacies and Key Skills) of the 2020 NJSL:**
 - o “This standard outlines key literacies and technical skills such as critical thinking, global and cultural awareness, and technology literacy that are critical for students to develop to live and work in an interconnected global economy.”

***Climate Change:** The state of New Jersey has mandated instruction in, “Climate Change across all content areas, leveraging the passion students have shown for this critical issue and providing them opportunities to develop a deep understanding of the science behind the changes and to explore the solutions our world desperately needs.”
6. ***Amistad Law: N.J.S.A. 18A 52:16A-88:**
 - o The inclusion of lessons and resources/texts dealing with the African slave trade, slavery in America, the vestiges of slavery in this country and the contributions of African-Americans to our society will be implemented in English and Social Studies courses in accordance with state law: “Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.”
7. ***Holocaust Law: N.J.S.A. 18A 35-28:**
 - o The inclusion of lessons and resources/texts that enable pupils to identify and analyze applicable theories concerning human nature and behavior; to understand that genocide is a consequence of prejudice and discrimination; and to understand that issues of moral dilemma and conscience have a profound impact on life will be implemented in English and Social Studies courses in accordance with state law: “Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.”
8. ***LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35:**
 - o A transformative approach to the inclusion of lessons and resources/texts on the contributions and issues concerning the LGBTQ+ population and people with disabilities will be implemented across all core subjects in accordance with state law: “A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district’s implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36). A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.”
9. ***Asian American and Pacific Islanders Legislation: N.J.S.A 4021/A6100:**
 - o The inclusion of lessons and resources/texts on the history and contributions of Asian Americans and Pacific Islanders, will enable New Jersey’s schools to provide a curriculum that reflects the diversity of our state. In accordance with state law: “A board of education shall include instruction on the history and contributions of Asian Americans and Pacific Islanders in an appropriate place in the curriculum of students in grades kindergarten through as part of the school district’s implementation of the New Jersey Student Learning Standards in Social Studies.”
10. Acquisition/development/refinement of the higher-order critical thinking skills aligned with the *Revised Bloom’s Taxonomy of Cognitive Objectives*

Section III: Curriculum Modifications

The *AP Calculus BC* curriculum is subject to case-by-case modifications to support/advance the needs of all students, including special education students, English language learners, gifted students and those at risk of school failure. These modifications are based on Individualized Learning Programs (IEPs), recommendations made by the district’s English Language Learners (ELL) coordinator, feedback from members of the Intervention & Referral Services Team (*I&RS*) for at-risk students, and 504 Plans.

Coursework and assessments will be modified on an individual basis for students when necessary. Modifications may include but are not limited to those outlined on the [Modifications/Accommodations for Mathematics Courses](#) chart.

Section IV: Preparation for Standardized Testing

Instruction in *AP Calculus BC* is aligned with the requirements of state and national standardized assessments, including the *NJGPA*, *NJSLA*, the *ACT*, the *PSAT*, and the *SAT*.

Section V: Curriculum Pacing Guide

Curriculum Pacing Guide	
Course Title: <i>AP Calculus BC</i>	Grade Level: 11 & 12
Unit I: Functions	Week 1
Unit II: Continuity and Limits as Properties of Functions	Weeks 2-4
Unit III: The Derivative	Weeks 5-7
Unit IV: The Derivative in Graphing and Applications	Weeks 8-13
Unit V: Integration	Weeks 14-16
Unit VI: Differential Equations and Methods of Integration	Weeks 17-20
Unit VII: Applications of Definite Integral in Geometry	Weeks 21-23
Unit VIII: Infinite Series	Weeks 24-27
Unit IX: Calculus of Parametric, Vector and Polar Functions	Weeks 28-30
Unit X: Post AP Exam Project	Weeks 31-40

Section VI: Primary Texts and Year-Long Instructional Resources

The following texts and instructional resources are employed for all students in *AP Calculus BC*:

- Google Classroom
- *Common Sense Education* (www.common sense.org)
- *Calculus, Graphical, Numerical, Algebraic* By: Finney, Demana, Waits, Kennedy
- Ti-89 Titanium Graphing Calculator
- AP Classroom
- Kuta Software

- [Kahn Academy](#)
- [Desmos](#)

Section VII: Grading Formula and Assessment Modes

Marking period grades in *AP Calculus BC* are determined via a percentage weighting model. The specific grading categories and weightings of each will be determined before the start of each academic year and will be published in the posted/distributed course syllabi.

Assessments in *AP Calculus BC* vary greatly in format, scope/content/skills assessed, and alternative assessments, differentiation in assessments and choice will be incorporated as appropriate. Preliminary assessments of each format will be used as benchmarks and summative assessments will be created/revised collaboratively each year and planned by members of the *Dance* instructional team to inform future learning and to measure student growth.

Section VIII: Unit Templates

The following unit templates have been established for the *AP Calculus BC* curriculum by the *AP Calculus BC* instructional team:

Unit I: Functions		
Unit Summary		
In this unit, students will review the skills of constructing and interpreting graphs of functions. It also introduces the use of a graphing utility as a tool to investigate mathematical ideas, to support analytic work, and to solve problems with numerical and graphical methods.		
Standards/Core Ideas/Performance Expectations/Progress Indicators		
The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in <i>AP Calculus BC</i> :		
<ul style="list-style-type: none"> • <i>2023 New Jersey Student Learning Standards: Mathematics</i> <ul style="list-style-type: none"> ○ MP.1-8 ○ F.IF.A.1-2, B.4 & C.7, F.TF.A.3 • <i>2023 New Jersey Student Learning Standards English Language Arts</i> <ul style="list-style-type: none"> ○ L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, R.I.MF.11-12.6 • <i>2020 New Jersey Student Learning Standards: Computer Science and Design Thinking</i> <ul style="list-style-type: none"> ○ 8.1.12.CS3, 8.1.12.DA.2 & 4, 8.1.12.ED.3, 8.1.12.ETW.3, 8.1.12.EC.3 • <i>2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills</i> <ul style="list-style-type: none"> ○ 9.4.8.DC.4 & 6, 9.4.8.TL.2 		
Unit Essential Questions	Unit Enduring Understandings	
<ul style="list-style-type: none"> • What is a function? • What are different techniques for viewing and interpreting graphs? • What are important characteristics to consider when interpreting graphs of functions? 	<ul style="list-style-type: none"> • A function is a relation between a set of inputs having one output each. • A graph can be viewed using a graphing calculator or from a sketch drawn based on the important characteristics of the function. • When interpreting a graph, it is useful to determine minimums, maximums, increasing and decreasing intervals, domain and range, and intercepts. 	
Evidence of Learning		
Formative & Alternative Assessments:	Benchmark & Summative Assessments:	Resources Needed:
<ul style="list-style-type: none"> • Classwork • Homework • Graphing Functions Exit Slip • Evaluating Trig Exit Slip • Individual student check-ins with teacher 	<ul style="list-style-type: none"> • Summer Assignment • Summer Assignment Test (Benchmark) 	<ul style="list-style-type: none"> • Ti-89 Calculator • PreCalculus Notes • Desmos Graphing Calculator

Unit II: Continuity and Limits as Properties of Functions

Unit Summary

In this unit, students will define and calculate limits of function values by substitution, graphical analysis, numerical approximation, or algebra. The students will use limits to test functions for continuity.

Standards/Core Ideas/Performance Expectations/Progress Indicators

The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in *AP Calculus BC*:

- *2023 New Jersey Student Learning Standards: Mathematics*
 - MP.1-8
 - F.IF.B.4 & C.7
- *2023 New Jersey Student Learning Standards English Language Arts*
 - L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
 - 8.1.12.1C.1, 8.2.12.IH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills*
 - 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1

Unit Essential Questions

- What is a limit?
- What are the different strategies for defining limits?
- What is continuity?

Unit Enduring Understandings

- Limits introduce the subtle distinction between evaluating a function at a point and considering what value the function is approaching, if any, as x approaches a point. This distinction allows us to extend our understanding of asymptotes and holes in graphs with formal definitions of continuity.
- Limits can be defined graphically, algebraically, tabular, or using trigonometric identities. Additionally, once the concept of derivatives is introduced, limits can also be defined using L'Hopital's rule.
- A function is continuous when there are no gaps or breaks in the graph. They are also easily stated as holes, jumps, or vertical asymptotes.

Evidence of Learning

Formative & Alternative Assessments:

- Classwork
- Homework
- Continuity Exit Ticket
- Limits Exit Ticket
- Timed Limits MC Practice
- AP Classroom-Continuity
- Individual check-ins with teacher

Benchmark & Summative Assessments:

- Limits Quiz
- Chapter 2 Test

Resources Needed:

- TI-89 Graphing Calculator
- Desmos Graphing Calculator
- Calculus Textbook
- AP Classroom

Unit III: The Derivative

Unit Summary

In this unit, students will find the derivative of a function and explore the concept of differentiability both graphically and analytically. Students will be taught the concepts/rules for differentiation.

Standards/Core Ideas/Performance Expectations/Progress Indicators

The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in *AP Calculus BC*:

- *2023 New Jersey Student Learning Standards: Mathematics*
 - MP.1-8
 - F.IF.A.1-2, B.4,6 & C.7, F.TF.A.3
- *2023 New Jersey Student Learning Standards English Language Arts*
 - L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
 - 8.1.12.1C.1, 8.2.12.IH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills*
 - 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1

Unit Essential Questions

Unit Enduring Understandings

<ul style="list-style-type: none"> • What is the derivative? • Why is the derivative important in Calculus? • What is the relationship between differentiability and continuity? • What rules can be used to determine the derivative of a function? • How can the derivative be applied to real-life applications? 	<ul style="list-style-type: none"> • The derivative gives the value of the slope of the tangent line to a curve at a point. • Derivatives allow us to determine rates of change at an instant by applying limits to knowledge about rates of change over intervals. • To be considered a differentiable function, the function must also be continuous (determined by the characteristics in the previous unit). In addition to continuity, the function must have defined one-sided slopes that are equal. • The power rule, product rule, quotient rule or chain rule as well as implicit differentiation can be used to determine the derivative of a function. • Derivatives give the rates at which things change in the world (ie. velocity, acceleration).
Evidence of Learning	
Formative & Alternative Assessments: <ul style="list-style-type: none"> • Classwork • Homework • 3.1 Exit Ticket • 3.4 Graded Warm Up • AP Classroom: Chapter 3 Mixed Practice • Individual student check-ins with teacher 	Benchmark & Summative Assessments: <ul style="list-style-type: none"> • 3.1-3.3 Quiz • 3.4-3.6 Quiz • Chapter 3 Test
Resources Needed: <ul style="list-style-type: none"> • TI-89 Graphing Calculator • Desmos Graphing Calculator • Calculus Textbook • AP Classroom 	

Unit IV: The Derivative in Graphing and Applications	
Unit Summary	
<p>In this unit, students will review the skills of constructing and interpreting graphs of functions. It also introduces the use of a graphing utility as a tool to investigate mathematical ideas, to support analytic work, and to solve problems with numerical and graphical methods.</p>	
Standards/Core Ideas/Performance Expectations/Progress Indicators	
<p>The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in <i>AP Calculus BC</i>:</p> <ul style="list-style-type: none"> • <i>2023 New Jersey Student Learning Standards: Mathematics</i> <ul style="list-style-type: none"> ○ MP.1-8 ○ F.IF.A.1-2, B.4,6 & C.7, F.TF.A.3 • <i>2023 New Jersey Student Learning Standards English Language Arts</i> <ul style="list-style-type: none"> ○ L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6 • <i>2020 New Jersey Student Learning Standards: Computer Science and Design Thinking</i> <ul style="list-style-type: none"> ○ 8.1.12.1C.1, 8.2.12.ITH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1 • <i>2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills</i> <ul style="list-style-type: none"> ○ 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1 	
Unit Essential Questions	Unit Enduring Understandings
<ul style="list-style-type: none"> • Since certain indeterminate forms seem to actually approach a limit, how can we determine that limit, provided it exists? • How can the derivative be interpreted in various contextual problems? • How does the Mean Value Theorem relate to the concept of continuity and differentiability? • What is the significance of the Extreme Value Theorem? 	<ul style="list-style-type: none"> • Using L'hospital's rule, we can determine a limit provided that it exists. • 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) or related rates and optimization to solve problems. • The Mean Value Theorem states that if a function is continuous over a closed interval, and differentiable over the same open interval, then there exists at least one value where the average rate of change is equal to the instantaneous rate of change. • The Extreme Value Theorem is used to find the maximum and minimum values of a continuous function in a closed interval.

<ul style="list-style-type: none"> How are derivatives helpful when determining the behavior of a graph of a function? 	<ul style="list-style-type: none"> The first derivative will determine maximums and minimums, and the intervals of increase and decrease, and the second derivative will relate points of concavity with the interval of concavity.
Evidence of Learning	
Formative & Alternative Assessments: <ul style="list-style-type: none"> Classwork Homework MVT/EVT Graded Warm Up AP Classroom Related Rates and Optimization Matching Graphs Activity FRQ's-Analyzing Graphs Graphing Warm Up Multiple Choice Calculator questions Individual student check-ins with teacher 	Benchmark & Summative Assessments: <ul style="list-style-type: none"> 4.1-4.3 Quiz 4.4-4.6 Quiz Chapter 4 Test Summative #1
Resources Needed: <ul style="list-style-type: none"> TI-89 Graphing Calculator Desmos Graphing Calculator Calculus Textbook AP Classroom Desmos Activity: "Mean Value Theorem Investigation" 	

Unit V: Integration	
Unit Summary	
<p>This unit establishes the relationship between differentiation and integration using the Fundamental Theorem of Calculus. Students will begin by exploring the contextual meaning of areas of certain regions bounded by rate functions. The students will discover that integration determines the accumulation of change over an interval, just as differentiation determines the instantaneous rate of change at a point. Students work with integrals that have one or two infinite bounds.</p>	
Standards/Core Ideas/Performance Expectations/Progress Indicators	
<p>The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in <i>AP Calculus BC</i>:</p> <ul style="list-style-type: none"> <i>2023 New Jersey Student Learning Standards: Mathematics</i> <ul style="list-style-type: none"> MP.1-8 G.CO.C.10-11, G.SRT.C.6-8, N.Q.A.1 <i>2023 New Jersey Student Learning Standards English Language Arts</i> <ul style="list-style-type: none"> L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6 <i>2020 New Jersey Student Learning Standards: Computer Science and Design Thinking</i> <ul style="list-style-type: none"> 8.1.12.1C.1, 8.2.12ITH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1 <i>2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills</i> <ul style="list-style-type: none"> 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1 	
Unit Essential Questions	Unit Enduring Understandings
<ul style="list-style-type: none"> How are area and integrals related? How can definite integrals be approximated? How are integrals and derivatives related? What is the Fundamental Theorem of Calculus? What techniques can be used to evaluate an integral? What is an improper integral? 	<ul style="list-style-type: none"> The integral represents the area under a curve over a particular interval which determines the accumulation of change over that interval. Definite integrals can be approximated using geometric or numerical methods (Riemann Sums). Integrals and derivatives are considered inverse operations. The Fundamental Theorem of Calculus links the concept of differentiating a function with the concept of integrating a function. An integral can be evaluated by applying The Fundamental Theorem of Calculus and finding the antiderivative of the function. In some cases, more complex methods are needed to simplify the function such as u-substitution, integration by parts, long division, or completing the square. An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration.
Evidence of Learning	
Formative & Alternative Assessments: <ul style="list-style-type: none"> Classwork 	Benchmark & Summative Assessments: <ul style="list-style-type: none"> FTC Mini Quiz
Resources Needed: <ul style="list-style-type: none"> TI-89 Graphing Calculator Desmos Graphing Calculator 	

<ul style="list-style-type: none"> • Homework • 5.1-5.2 Graded HW • U-substitution Exit Slip • AP Classroom: Integration Techniques • Individual student check-ins with teacher 	<ul style="list-style-type: none"> • Integration Methods Quiz • Chapter 5 Test 	<ul style="list-style-type: none"> • Calculus Textbook • AP Classroom
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Unit VI: Differential Equations and Methods of Integration

Unit Summary

In this unit, students will review the skills of constructing and interpreting graphs of functions. It also introduces the use of a graphing utility as a tool to investigate mathematical ideas, to support analytic work, and to solve problems with numerical and graphical methods.

Standards/Core Ideas/Performance Expectations/Progress Indicators

The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in *AP Calculus BC*:

- *2023 New Jersey Student Learning Standards: Mathematics*
 - MP.1-8
 - F.BF.B.5, G.CO.C.10-11, G.SRT.C.6-8
- *2023 New Jersey Student Learning Standards English Language Arts*
 - L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, R.I.MF.11-12.6
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
 - 8.1.12.1C.1, 8.2.12.IH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills*
 - 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1

Unit Essential Questions

- What is a differential equation?
- What are slope fields used for?
- What is the separation of variables in differential equations?
- How can we approximate the solution to a differential equation?
- How are exponential equations used with differential equations?
- What antidifferentiation techniques can be used to evaluate more complex integrals?

Unit Enduring Understandings

- A differential equation is an equation that contains one or more terms and the derivatives of one variable (i.e., dependent variable) with respect to the other variable (i.e., independent variable).
- A slope field is a visual representation of a differential equation in two dimensions. This shows us the rate of change at every point and we can also determine the curve that is formed at every single point. So each individual point of a slope field (or vector field) tells us the slope of a function.
- Separation of variables is used for solving ordinary and partial differential equations, in which algebra allows one to rewrite an equation so that each of two variables occurs on a different side of the equation.
- Euler's method provides a procedure for approximating a solution to a differential equation or a point on a solution curve.
- Specific applications of finding general and particular solutions to differential equations include motion along a line and exponential growth and decay.
- When an integral is more complex, basic integration methods may not be enough to evaluate the integral. In some cases, we may need to first simplify the integral using partial fraction decomposition.

Evidence of Learning

Formative & Alternative Assessments:

- Classwork
- Homework
- Slope Field Matching
- FRQ's-Exponential Growth and Decay

Benchmark & Summative Assessments:

- FRQ's-Differential Equations (Benchmark)
- Chapter 6 Test

Resources Needed:

- TI-89 Graphing Calculator
- Desmos Graphing Calculator
- Calculus Textbook
- AP Classroom
- Slope Field Graphs

<ul style="list-style-type: none"> Exponential Growth and Decay MC practice AP Classroom Differential Equations Practice Individual student check-ins with teacher 		
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Unit VII: Applications of the Definite Integral in Geometry

Unit Summary

In this unit, students will learn how to find the average value of a function, model particle motion, and net change, and determine areas and volumes defined by the graphs of functions.

Standards/Core Ideas/Performance Expectations/Progress Indicators

The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in *AP Calculus BC*:

- 2023 New Jersey Student Learning Standards: Mathematics
 - MP.1-8
 - G.CO.C.10-11, G.SRT.C.6-8, N.Q.A.1
- 2023 New Jersey Student Learning Standards English Language Arts
 - L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6
- 2020 New Jersey Student Learning Standards: Computer Science and Design Thinking
 - 8.1.12.IC.1, 8.2.12.ITH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1
- 2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills
 - 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2, 7-9, 9.4.12.GCA.1

Unit Essential Questions

- How can we determine the amount of change over a period of time? (ie. the amount of cars that pass through an intersection in a certain time period)?
- How are position, velocity, and acceleration connected through integration?
- How can we use calculus to determine the area between two curves?
- How can we use the area to determine the volume of solids by cross-section or by revolution?
- How can we use integrals to calculate length along curves?

Unit Enduring Understandings

- Definite integrals allow us to solve problems involving the accumulation of change over an interval when given the function to represent the rate of change.
- The integral can be used to move between position, velocity, and acceleration. The antiderivative of acceleration is velocity and the antiderivative of velocity is position.
- The definite integral can be used to determine the area between two curves. We must determine whether the area is better defined with respect to the x-axis or the y-axis and if the curves intersect multiple times.
- Using area to determine the volume of solids by cross-section or by revolution involves a methodical approach depending on whether you are dealing with a solid of known cross-sectional area or a solid generated by rotating a region around an axis. If you have a solid where every cross-section perpendicular to a certain axis has an area that can be expressed as a function of the position along that axis, you can use integration to find the volume. If you have a region in the xy-plane that is revolved around a horizontal or vertical axis then you can follow a similar approach, but your cross sections will specially be circular.
- We can determine the length of a curve using our knowledge of evaluating integrals, finding the derivative of a function, and the arc length formula.

Evidence of Learning

Formative & Alternative Assessments:

- Classwork
- Homework
- 7.1 Alternative Assessment
- Volume Introductory Activity

Benchmark & Summative Assessments:

- Area and Volume Quiz
- Chapter 7 Test
- Summative #2

Resources Needed:

- TI-89 Graphing Calculator
- Desmos Graphing Calculator
- Calculus Textbook
- AP Classroom
- Materials for Volume Activity

<ul style="list-style-type: none"> • AP Classroom: Integrals of Net Change Practice • Individual student check-ins with teacher 		
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Unit VIII: Infinite Series

Unit Summary

In this unit, students will define a sequence and determine whether it is arithmetic, geometric, or other. Students will be able to discover the calculus of infinite series as the pioneers of calculus did: proceeding intuitively, accepting what works, and rejecting what does not. They will also focus on the crucial question of convergence and take a careful look at it.

Standards/Core Ideas/Performance Expectations/Progress Indicators

The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in *AP Calculus BC*:

- *2023 New Jersey Student Learning Standards: Mathematics*
 - MP.1-8
 - F.BF.A.2
- *2023 New Jersey Student Learning Standards English Language Arts*
 - L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6
- *2020 New Jersey Student Learning Standards: Computer Science and Design Thinking*
 - 8.1.12.IC.1, 8.2.12.IH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1
- *2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills*
 - 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1

Unit Essential Questions

- How do you determine whether a series converges or diverges?
- How can you find the sum of a geometric series?
- What is conditional convergence?
- How can you use an alternating series error bound?
- Why are Taylor Polynomials used?
- What is the Lagrange Error Bound?
- How can you determine a radius and an interval of convergence for a power series?
- What is the difference between a Maclaurin and a Taylor series?

Unit Enduring Understandings

- You may use a variety of convergence tests to determine if a series converges, including nth term (for divergence only), p-series, geometric series, alternating series, harmonic series, ratio, root, integral, and comparison.
- A geometric series, where the absolute value of the common ratio is less than 1, will converge to a sum of the first term divided by the difference of 1 and the common ratio, r .
- An alternating series may converge conditionally or absolutely. If the absolute value of the terms will converge on its own, without an alternator, then the series converges absolutely. Otherwise, the series may only converge conditionally.
- The alternating series error bound can be used to bound how far a partial sum is from the value of the infinite series.
- Taylor Polynomials are used to represent a function at a point. Polynomials are the easiest of the functions to work with, derive, integrate, and evaluate. By using a polynomial, we can estimate the actual values of more complex functions.
- The Lagrange Error Bound can be used to determine a maximum interval for the error of a Taylor Polynomial approximation to a function.
- If a power series converges, it will converge either at a single point (radius is 0), or over an interval of convergence. The ratio test can be used to determine the radius of convergence, but if finite then the endpoints must also be tested to determine if they will be included. Over this interval of convergence, the series may be used in place of the original function for evaluating, deriving or integrating.
- A Maclaurin series is a Taylor series centered at 0.

Evidence of Learning

Formative & Alternative Assessments:

- Classwork
- Homework

Benchmark & Summative Assessments:

- Convergence Tests Quiz

Resources Needed:

- TI-89 Graphing Calculator
- Desmos Graphing Calculator

<ul style="list-style-type: none"> Convergence Tests exit slip Convergence Tests graded warm-up AP Classroom: convergence tests practice Individual student check-ins with teacher 	<ul style="list-style-type: none"> Taylor Polynomials/Lagrange FRQ Chapter 8 Test 	<ul style="list-style-type: none"> Calculus Textbook AP Classroom
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Unit IX: Calculus of Parametric, Vector and Polar Functions

Unit Summary

In this unit, students will apply their understanding of single variable calculus in three kinds of two- variable contexts, enabling students to analyze some new kinds of curves (parametric and polar) and to analyze motion in the plane that does not proceed along a straight line.

Standards/Core Ideas/Performance Expectations/Progress Indicators

The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in *AP Calculus BC*:

- 2023 New Jersey Student Learning Standards: Mathematics
 - MP.1-8
 - N.CN.B.4
- 2023 New Jersey Student Learning Standards English Language Arts
 - L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6
- 2020 New Jersey Student Learning Standards: Computer Science and Design Thinking
 - 8.1.12.1C.1, 8.2.12ITH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1
- 2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills
 - 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1

Unit Essential Questions

- How do you find a derivative of a parametric equation?
- How do you find the second derivative of a parametric function?
- How do you find the length of a curve in the plane defined by parametric functions?
- How do you calculate derivatives and integrals of vector-valued and polar functions?

Unit Enduring Understandings

- To find the derivative of a parametric equation, you must divide the derivative of y with respect to t by the derivative of x with respect to t .
- To find the second derivative of y with respect to x for a parametric function, you find dy/dx as stated above and then divide that by the derivative of x with respect to t .
- The length of a parametrically defined curve can be calculated using a definite integral.
- The same methods for calculating derivatives and integrals of real-valued functions can be extended to vector-valued and polar functions.

Evidence of Learning

Formative & Alternative Assessments:

- Classwork
- Homework
- AP Classroom Practice
- Vector Calculus exit slip
- Individual student check-ins with teacher

Benchmark & Summative Assessments:

- Parametric/Vector Quiz
- Polar FRQ
- Chapter 10 Test
- Summative #3

Resources Needed:

- TI-89 Graphing Calculator
- Desmos Graphing Calculator
- Calculus Textbook
- AP Classroom

Unit X: Post AP Exam Project- "How to Be an Adult"

Unit Summary

In this unit, students will demonstrate their cumulative knowledge of mathematical concepts in an end of year project. Students will research mortgage rates, homes, tax rates, cars and will use this information to create a budget with a given profession and certain monetary parameters.

Standards/Core Ideas/Performance Expectations/Progress Indicators

The state standards outlined below, and established by the New Jersey Department of Education, will guide instruction throughout this unit in *AP Calculus BC*:

<ul style="list-style-type: none"> 2023 New Jersey Student Learning Standards: Mathematics <ul style="list-style-type: none"> MP.1-8 G.CO.C.10-11, G.SRT.C.6-8, N.Q.A.1 2023 New Jersey Student Learning Standards English Language Arts <ul style="list-style-type: none"> L.VL.11-12.3.A, W.AW.11-12.1.A & E, W.IW.11-12.2.A, W.NW.11-12.3.A-E, SL.II.11-12.2, SL.PI.11-12.4, RI.MF.11-12.6 2023 New Jersey Student Learning Standards: Science <ul style="list-style-type: none"> HS-ETS1-1, HS-ESS3-2 2020 New Jersey Student Learning Standards: Computer Science and Design Thinking <ul style="list-style-type: none"> 8.1.12.1C.1, 8.2.12.IH.1-3, 8.2.12.ETW.1, 8.2.12.ETW.4, 8.2.12.EC.1 2020 New Jersey Student Learning Standards: Career Readiness, Life Literacies, and Key Skills <ul style="list-style-type: none"> 9.4.12.CI.1-3, 9.4.12.CT.1-4, 9.4.12.IML.1-2,7-9, 9.4.12.GCA.1 		
Unit Essential Questions	Unit Enduring Understandings	
<ul style="list-style-type: none"> What are the key components of buying a house? What are the key components of purchasing a car? What are other factors of a monthly budget? *What is the difference between conventional cars and electric cars? 	<ul style="list-style-type: none"> In order to purchase a house, students will need to understand mortgage rates and down payments. Students need to understand their budget for purchasing a car and how to incorporate car insurance into their monthly budget. Students will understand that they need to research other expenses such as electricity, gas, food bills, cell phones, etc., and make sure they are organized in their budget. *Conventional cars require gas to move and electric cars can function without using any gasoline at all. 	
Evidence of Learning		
Formative & Alternative Assessments: <ul style="list-style-type: none"> Classwork Homework Excel spreadsheet Peer rubric Photos of cars, home Individual student check-ins with teacher 	Benchmark & Summative Assessments: <ul style="list-style-type: none"> How to Adult-Final Project 	Resources Needed: <ul style="list-style-type: none"> How to Adult Project TI-89 calculator Home Websites Bank Websites Car Websites Microsoft Excel

Section IX: Unit Reflection

The *AP Calculus BC* instructional team must confer upon the completion of each instructional unit in the *AP Calculus BC* curriculum and rate the degrees to which the instructional units meet performance criteria established by the New Jersey Department of Education using the Unit Reflection Form. Completed unit reflection forms must be submitted to the Department Supervisor for approval upon completion of curriculum implementation with a complementing list of suggested modifications to the *AP Calculus BC* curriculum.

Unit Reflection Form: <i>AP Calculus BC</i>			
Lesson Activities:	Strongly	Moderately	Weakly
Foster student use of technology as a tool to develop critical thinking, creativity, and innovation skills;			
Are challenging and require higher-order thinking and problem-solving skills;			
Allow for student choice;			
Provide scaffolding for acquiring targeted knowledge/skills;			

Integrate modern, global perspectives, especially those regarding diversity, genocide, global issues, and historical ones regarding racial relations;			
Integrate 21 st century skills;			
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills;			
Are varied to address different student learning styles and preferences;			
Are differentiated based on student needs;			
Are student-centered with the teacher acting as a facilitator and co-learner during the teaching and learning process;			
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives;			
Provide opportunities for student reflection and self-assessment;			
Provide data to inform and adjust instruction to better meet the varying needs of learners.			

Appendix
Writing Instruction and the RFH Community

Writing instruction should happen across the RFH Community. Writing across the curriculum is a philosophy that advances the belief that writing is a method of learning. Since all departments are committed to helping students learn, writing must be used as a methodology to advance student learning.

Each academic discipline has its own unique conventions, formats and structures. It is the responsibility of each department to agree upon domain-specific writing praxes, model them for students, and require them to utilize them on a consistent basis. Students must understand that acceptable writing in one domain may not be acceptable writing in another area. The development of domain-specific writing skills supports the overall development of the student writer because all writing is grounded in the writing situation: audience, context, purpose, subject, and writer. Representatives from the academic disciplines must share their domain-specific writing praxes with each other, identify intersections, and determine how to address perceived gaps that limit student learning.

Students must experience writing situations that help them learn how to think creatively and critically and communicate effectively in the academic disciplines. Writing instruction, regardless of the academic discipline, must always reinforce student understanding of the writing situation. When students experience writing situations, they must study examples of domain-specific writing in order to understand how writers communicate in discipline-related contexts. This does not mean information embedded in textbooks. Domain-specific writing is writing that is used to inform and influence readers as it draws them into an established circle of discourse. Students must use these non-fiction texts to develop the close reading skills that will shape their own writing. Focused engagement with domain-specific writing should not be limited to basic reading comprehension and topical understanding. It must also include the analysis of the writing situation that is represented in the text: audience, context, purpose, subject, and writer. The close reading of well-written texts—regardless of the domain—will show students the importance of writing mechanics, diction, and syntax. The development of close reading skills will also help the students grow in terms of their ability to construct and advance independent and original claims that are well-supported by evidence. Domain-specific writing is grounded in positioning of claims and the effective use of evidence.

The final written product is important; nevertheless, the learning that results in this production must not be devalued. The writing process is not limited to the basic steps of planning, drafting, revising, and editing/proofreading. It is a complex sequence of critical and creative thinking and writing that leads to the production of a text that provides evidence of learning and understanding. Students must ultimately develop the ability to self-assess the effectiveness of their writing as a representation of the writing situation. Without the use of models that evidence learning and understanding, students will not develop the ability to self-assess their own work—the true outcome of the writing process.

What types of writing situations should RFH students engage in?

RFH students should engage in writing situations across the curriculum that require them to:

- write to improve mechanical proficiency, diction usage, and syntactical sophistication
- write to narrate, describe, and reflect
- write to summarize and report
- write to classify and define
- write to explain how process leads to an outcome
- write to compare, contrast and evaluate
- write to speculate on cause and effect
- write to propose solutions and solve problems
- write to analyze

These writing situations should be positioned in a coordinated, developmental sequence that extends across the academic disciplines.

Upon Completion of Grade 12, RFH students must be ready to transition to the following writing situations:

- write to analyze
- write to persuade (argument)

The core foci of first-year college writing courses are analysis and argument. These courses orient the students to the demands and expectations of writing for the academic culture of college. At colleges/universities with carefully coordinated writing programs, students must demonstrate proficiency in analysis and argument before they transition to upper level courses that require them to engage in the following writing situation:

- write to investigate (research)