**Greenwich Public Schools Curriculum Overview**

ADVANCED PLACEMENT CALCULUS BC

Personalized learning is achieved through standards-based, rigorous and relevant curriculum that is aligned to digital tools and resources.

*Note: Teachers retain professional discretion in how the learning is presented based on the needs and interests of their students.*

## Course Description

AP Calculus BC
Full Year
029150 6 Blocks 1 Credit
Prerequisite: Honors Pre-Calculus with a B+ or better, or completion of AP Calculus AB
Topics include limits, differentiation, integration and analysis of infinite series and applications of these topics. This course is the equivalent to two semesters of college Calculus. Students taking this course are expected to take the corresponding national Advanced Placement exam given in May.

## Unit Guide

Chapter 1: Limits and their Properties
Chapter 2: Differentiation
Chapter 3: Applications of Differentiation
Chapter 4: Integration
Chapter 5: Logarithmic, Exponential and other transcendental functions
Midterm Review & Midterm Exam*
Chapter 6: Area and Volume
Chapter 7: More on Integration
Chapter 8 Part I: Sequences and Series
Chapter 8 Part II: Taylor Polynomials and Taylor Series
Chapter 9: Polar, Parametric and Vector-Defined functions
Final Review & Final Exam*

***Note**: Semester exam review packets, answer keys and formula sheets can be found by joining our **Schoology** *Math Department Review Course*, using COURSE access code P9V9X-H6V37.

## Common Core Mathematical Practices

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of others.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and make use of structure.

**AP CALCULUS Mathematical Practices (page 14 of hyperlinked document):**

- *Implementing Mathematical Processes:* Determine expressions and values using mathematical procedures and rules
- *Connecting Representations:* Translate mathematical information from a single representation or across multiple representations.
- *Justification:* Justify reasoning and solutions.
- *Communication and Notation:* Use correct notation, language, and mathematical conventions to communicate results or solutions.

**Enduring Understandings**

- *Chapter 1*:
  - Calculus allows us to generalize knowledge about motion to diverse problems involving change.
  - The concept of a limit can be used to understand the behavior of functions.
  - Continuity is a key property of functions that is defined using limits.
  - Reasoning with definitions, theorems, and properties can be used to justify claims about limits.
  - Derivatives allow us to determine rates of change at an instant by applying limits to knowledge about rates of change over intervals.
- *Chapter 2*:
  - The derivative of a function is defined as the limit of a difference quotient and can be determined using a variety of strategies.
  - Recognizing that a function's derivative may also be a function allows us to develop knowledge about the related behaviors of both.
  - Recognizing opportunities to apply derivative rules can simplify differentiation.
  - Derivatives allow us to determine rates of change at an instant by applying limits to knowledge about rates of change over intervals.
  - A function's derivative can be used to understand some behaviors of the function.
- *Chapter 3*:
  - Existence theorems allow us to draw conclusions about a function's behavior on an interval without precisely locating that behavior.
  - The Mean Value Theorem connects the behavior of a differentiable function over an interval to the behavior of the derivative of that function at a particular point in the interval.
  - A function's derivative, which is itself a function, can be used to understand the behavior of the function.
  - Derivatives allow us to solve real-world problems involving rates of change.
- *Chapter 4*:
  - Antidifferentiation is the inverse process of differentiation
  - The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.
  - Definite integrals allow us to solve problems involving the accumulation of change over an interval.
  - Recognizing opportunities to apply knowledge of geometry and mathematical rules can simplify integration.
- *Chapter 5*:
  - Antidifferentiation is an underlying concept involved in solving separable differential equations.
  - Solving separable differential equations involves determining a function or relation given its rate of change.

- Solving differential equations allows us to determine functions and develop models.
- *Chapter 6*:
  - Definite integrals allow us to solve problems involving the accumulation of change in length, area or volume over an interval.
  - The definite integral of a function over an interval is a mathematical tool with many interpretations and applications involving accumulation.
- *Chapter 7*:
  - L'Hospital's Rule allows us to determine the limits of some indeterminate forms.
  - Recognizing opportunities to apply knowledge of geometry and mathematical rules can simplify integration.
  - The use of limits allows us to show that the areas of unbounded regions may be finite.
  - Solving differential equations allows us to determine functions and develop models.
- *Chapter 8*:
  - Applying limits may allow us to determine the finite sum of infinitely many terms.
  - Power series allow us to represent associated functions on an appropriate interval.
- *Chapter 9*:
  - Polar coordinates and rectangular coordinates describe the same points in different notations.
  - In some cases, the polar coordinate system provides a more elegant representation than the rectangular system.
  - Derivatives allow us to solve real-world problems involving rates of change.
  - Definite integrals allow us to solve problems involving the accumulation of change in length, area or volume over an interval.
  - Solving an initial value problem allows us to determine an expression for the position of a particle moving in the plane.
  - Recognizing opportunities to apply derivative rules can simplify differentiation.

**Essential Questions**

- *Chapter 1*:
  - What are the different kinds of limits and how are each limit calculated?
  - What is the difference between a one-sided limit and a two-sided limit?
  - What is the difference between an infinite limit and a limit at infinity, and how do you calculate each?
  - Can change occur at an instant?
  - How does knowing the value of a limit, or that a limit does not exist, help you to make sense of interesting features of functions and their graphs?
  - How do we close loopholes so that a conclusion about a function is always true?
  - How can a state determine the rate of change in high school graduates at a particular level of public investment in education (in graduates per dollar) based on a model for the number of graduates as a function of the state's education budget?
  - If you knew that the rate of change in high school graduates at a particular level of public investment in education (in graduates per dollar) was a positive number, what might that tell you about the number of graduates at that level of investment?
- *Chapter 2*:
  - What are derivatives used for?
  - How do you calculate the derivative for various kinds of functions?
  - Why are there so many different rules for differentiation?
  - What is the meaning of a derivative in the context of graphing, motion, and rate of change?
  - How does knowing the value of a limit, or that a limit does not exist, help you to make sense of interesting features of functions and their graphs?
  - Why do mathematical properties and rules for simplifying and evaluating limits apply to

differentiation?
    - If pressure experienced by a diver is a function of depth and depth is a function of time, how might we find the rate of change in pressure with respect to time?
- *Chapter 3*:
    - What does a derivative tell us about extremes?
    - What is optimization and how do we find it?
    - What are concavity and inflection?
    - How are the graphs of a function, its derivative and its second derivative related to one another?
    - How are position, velocity, speed, and acceleration related?
- *Chapter 4*:
    - What is a definite integral and how do I calculate it?
    - How is the definite integral set up in different contexts?
    - What is the relationship between a definite integral and the area under a curve?
    - What is the interpretation of the definite integral in the context of graphing and motion?
    - What are Riemann Rectangles and how are they used to estimate the definite integral?
    - How does the increasing or decreasing nature of a function relate to whether an approximation is an under- or over-estimate?
- *Chapter 5*:
    - How can we derive a model for the number of computers, C, infected by a virus, given a model for how fast the computers are being infected, $\frac{dC}{dt}$, at a particular time?
- *Chapter 6*:
    - How is finding the number of visitors to a museum over an interval of time based on information about the rate of entry similar to finding the area of a region between a curve and the x-axis?
- *Chapter 7*:
    - How does Integration by Parts work?
    - How do I decide what is *u* and what is *v* for Integration by Parts?
    - How is integrating to find areas related to differentiating to find slopes?
    - What about the nature of an integrand determines what techniques of integration to apply?
- *Chapter 8*:
    - What is the difference between a sequence and a series?
    - How do you determine if a sequence is convergent or divergent?
    - How do you determine if a series is convergent or divergent?
    - Why are there so many tests for convergence of a series?
    - Which series test do I use and when do I use it?
    - How can the sum of infinitely many discrete terms be a finite value or represent a continuous function?
    - What is a power series?
    - What is the relationship between a function and its Taylor polynomial?
    - How are the function's derivatives related to the coefficients of the Taylor Polynomial?
    - What is an error bound and how do you calculate it?
- *Chapter 9*:
    - What is the polar coordinate plane?
    - How do you convert between rectangular and polar coordinates?
    - How can we graph the "special" polar curves?
    - How can we model motion not constrained to a linear path?
    - How does the chain rule help us to analyze graphs defined using parametric equations or polar functions?

**Resources and Assured Experiences**

AP Classroom

Textbook Information:
Calculus of a Single Variable
Houghton Mifflin (2002~7th Edition)
ISBN 0-618-14916-3

**Quarterly Grading - Quarter Grades will be determined using the following components:**

- Participation (includes Classwork) = 5%
- Preparation (includes Homework) = 5%
- Assessments (both Summative & Formative) = 90%

**Connecticut Common Core State Standards**

- *Chapter 2*: CCSS.MATH.CONTENT.HSF.IF.A.2, B.4; HSA.REI.B.3.
- *Chapter 9*: CCSS.MATH.CONTENT.HSN.CN.B.4.

**AP CALCULUS Mathematical Practices (page 14 of hyperlinked document)**

- *Chapter 1*: 1.E, 2.B, 2.D, 3.B, 3C, 3.D, 3.E.
- *Chapter 2*: 1.C, 1.D, 1.E, 2.C, 2.D, 2.E, 3.C, 3.D, 3.E, 3.G, 4.C.
- *Chapter 3*: 1.D, 1.E, 2.A, 2.C, 2.D, 2.E, 3.D, 3.E, 3.F.
- *Chapter 4*: 1.D, 1.E, 1.F, 2.A, 2.B, 2.C, 2.D, 3.D, 4.B, 4.C.
- *Chapter 5*: 1.E, 2.C, 3.D, 3.F, 3.G, 4.D.
- *Chapter 6*: 1.D, 1.E, 2.B, 2.D, 3.D, 4.C, 4.E.
- *Chapter 7*: 1.D, 1.E, 2.B, 2.D, 3.D, 4.C, 4.E.
- *Chapter 8*: 1.E, 1.F, 2.C, 2.D, 3.B, 3.D.
- *Chapter 9*: 1.D, 1.E, 2.D, 3.D.