Somerville Public Schools

Office of Curriculum, Instruction, and Technology

Calculus

Grade 12

Prerequisite: Pre-Calculus

Credit Value: 5

ABSTRACT

Calculus is designed for the student who will be taking calculus in college, but is not necessarily seeking advanced placement credit. The course builds upon concepts from Pre-Calculus, such as inverse functions, exponential functions, logarithms, and limits, and applies them to a detailed study of differentiation and integration. Considerable time is spent on the applications of calculus to the fields of business, finance, and physics through the study of related rates, optimization, and analysis of curves and slopes. Students are also required to justify answers and conclusions using graphing calculators or *Microsoft Excel* spreadsheets and then effectively communicate their reasoning orally and in writing. Calculus provides students with the conceptual framework and analytical skills necessary for application to real-world problems and to be successful in the college calculus course.

Adopted by the Somerville Board of Education on June 19, 2007

SOMERVILLE PUBLIC SCHOOLS

Reaching for Excellence

Calculus – Grade 12

Month/ Marking Period	September	October	November	December	January
NJCCCS:	4.1B1, 4.2A3, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6	4.1B1-2, 4.2A3-4, 4.2C1, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6	4.2A3-4, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6, 5.7A3	4.2A3-4, 4.2B1-2, 4.2E1-2 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6, 5.7A3, 5.7B1	4.2A3-4, 4.2B1-2, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6
Essential Question:	How do the characteristics of functions connect to the traits of their graphs?	How do limits serve as a means to better understand functions and their behavior?	How is the concept of derivative representative of instantaneous rate of change?	How do exponential functions and logarithms apply to growth and decay?	When is implicit differentiation necessary?
Content:	Properties of Functions and Their Behavior	Limits of Functions	Derivatives	Derivatives of Exponential and Logarithmic Functions	Implicit Differentiation and Related Rates
Skills and Topics:	• interpret function and composite function notation • identify the domain and range of functions • graph functions • analyze trends among types of functions, their domains and ranges, and their graphs • justify conclusions about functions and their graphs using a graphing calculator • apply knowledge of functions to problem solving	• understand the concept of limit and its purpose • calculate the limit of functions • apply the properties of limits to aid in problem solving • formulate a definition of continuity using limits • determine the location of asymptotes using limits • compare and contrast average rate of change and instantaneous rate of change • develop a definition of a derivative by connecting limits with instantaneous rate of change	• calculate the derivative of a function using the limit definition • identify intervals on which a function is or is not differentiable • apply the power, chain, product, and quotient rules to find derivatives • perform algebraic manipulation on expressions to aid in the evaluation of derivatives • find the equation of the tangent line to a curve at a given point • integrate the concepts of position, velocity, and acceleration into higher-order derivatives	• calculate the derivative of natural exponential and logarithmic functions • calculate the derivative of exponential functions with bases other than e (the base of the natural logarithm) • apply skills to problem solving involving exponential and logarithmic functions (*e.g.*, growth/decay, sound waves)	• identify equations that require implicit differentiation • modify rules for finding derivatives in order to differentiate implicitly • apply implicit differentiation to solving related rate problems • compare and contrast effective and ineffective methods for solving related rate problems

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Calculus – Grade 12

Month/ Marking Period	September	October	November	December	January
Assessments:	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations Midterm examination
Resources:	Larson, Hostetler, & Edwards. (2006). *Calculus of a Single Variable*. Eighth Edition. Boston, MA: Houghton Mifflin Company.	Larson, Hostetler, & Edwards. (2006). *Calculus of a Single Variable*. Eighth Edition. Boston, MA: Houghton Mifflin Company.	Larson, Hostetler, & Edwards. (2006). *Calculus of a Single Variable*. Eighth Edition. Boston, MA: Houghton Mifflin Company.	Larson, Hostetler, & Edwards. (2006). *Calculus of a Single Variable*. Eighth Edition. Boston, MA: Houghton Mifflin Company.	Larson, Hostetler, & Edwards. (2006). *Calculus of a Single Variable*. Eighth Edition. Boston, MA: Houghton Mifflin Company.
Technology:	www.njpep.org/assessment Geometer sketchpad *Excel* spreadsheets Graphing calculators Internet Web Quests Wireless laptop computers SMART Boards Multimedia presentations	www.njpep.org/assessment Geometer sketchpad *Excel* spreadsheets Graphing calculators Internet Web Quests Wireless laptop computers SMART Boards Multimedia presentations	www.njpep.org/assessment Geometer sketchpad *Excel* spreadsheets Graphing calculators Internet Web Quests Wireless laptop computers SMART Boards Multimedia presentations	www.njpep.org/assessment Geometer sketchpad *Excel* spreadsheets Graphing calculators Internet Web Quests Wireless laptop computers SMART Boards Multimedia presentations	www.njpep.org/assessment Geometer sketchpad *Excel* spreadsheets Graphing calculators Internet Web Quests Wireless laptop computers SMART Boards Multimedia presentations
Writing:	Open-ended responses Conclusions and analysis of exploratory activities	Open-ended responses Conclusions and analysis of exploratory activities	Open-ended responses Conclusions and analysis of exploratory activities	Open-ended responses Conclusions and analysis of exploratory activities	Open-ended responses Conclusions and analysis of exploratory activities
Careers:	Applicable career options are discussed as they arise throughout the course. Career options include, but are not limited to, architects, biologists, chemists, economists, engineers, physicists, and any fields pertaining to navigation.				

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Reaching for Excellence

Calculus – Grade 12

Month/ Marking Period	February	March	April	May	June
NJCCCS:	4.1B1, 4.2A1, 4.2A3-4, 4.2E1, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6	4.1A2, 4.1B1-2, 4.2A1, 4.2A3-4, 4.2E1-2, 4.3B3-4, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6	4.2A1, 4.2A3-4, 4.2E1, 4.3B3-4, 4.4B2, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6	4.2A1, 4.2A3-4, 4.2E1-2, 4.3B3-4, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6	4.2A1, 4.2A3-4, 4.2C1-2, 4.2D2, 4.2E1-2, 4.3B3-4, 4.4A4-5, 4.5A1-5, 4.5B1-4, 4.5C1-6, 4.5D1-6, 4.5E1-3, 4.5F1-6
Essential Question:	How are derivatives used to locate the extrema and points of inflection of a function?	How does one use the derivative to solve optimization problems?	What is the fundamental theorem of calculus and what is its significance?	When is it necessary to integrate by parts?	What are the similarities and differences among the disk, washer, and shell methods of integration?
Content:	Graphing Functions Using Derivatives	More with Graphing and Applications of the Derivative	Indefinite and Definite Integrals	Methods of Integration	Solids of Revolution
Skills and Topics:	• relate knowledge of continuity to differentiability on an interval • use the first derivative to locate minimum and maximum values of a function • use the second derivative to determine concavity and to locate points of inflection of a function • sketch graphs of functions based on shape and tendency • determine answers and conclusions using a graphing calculator	• define "indeterminate forms" and provide examples • apply limits and L'Hopital's rule to aid in sketching graphs • formulate a process for solving optimization problems • connect concepts of minimums and maximums to solving problems related to geometry, economics, and banking • justify solutions as logical or illogical	• find indefinite integrals (*e.g.*, anti-derivatives) • recognize and interpret integral notation • approximate the area under a curve using sigma notation • develop a definition of definite integrals using Reimann Sums • state and apply the fundamental theorem of calculus • use the properties of integrals to aid in problem solving • determine the average value of a function and relate it to the mean value theorem	• apply the power rule and "u-substitution" to integrate functions • use integration-by-parts to integrate functions • improve the method of approximating the area under a curve using figures other than rectangles • apply the trapezoid rule to approximate a definite integral linear approximations of *f* • apply the Simpson's rule to approximate a definite integral using parabolic approximations of *f*	• calculate the area between curves using horizontal and vertical slicing • categorize integrals based on which type of slicing is most effective • find the volume of a solid of revolution using the disk, washer, and shell methods • predict the functions that form the boundaries of solids of revolutions

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Calculus – Grade 12

Month/ Marking Period	February	March	April	May	June
Skills and Topics:	• formulate and debate hypotheses concerning the existence of extrema and points of inflection and their location relative to one another on the graph of the function		• model the vector qualities of position, velocity, and acceleration by analyzing the positive or negative area under a curve	• apply integration techniques to solving problems involving work, pressure, center of mass, consumer surplus, and arc length	
Assessments:	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations	Warm-up activities Exploratory activities Discovery activities Class discussions Student participation Quizzes Tests Projects Presentations Final examination
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Careers:	Applicable career options are discussed as they arise throughout the calculus program. Career options include, but are not limited to, architects, biologists, chemists, economists, engineers, physicists, and any fields pertaining to navigation.				

Somerville Public Schools

Reaching for Excellence

Calculus
Course Requirements

Grade: 12 **Prerequisite:** Pre-Calculus **Credit Value:** 5 **Length of Course:** Academic Year

Course Description

Calculus is designed for the student who will be taking calculus in college, but is not necessarily seeking advanced placement credit. The course builds upon concepts from Pre-Calculus, such as inverse functions, exponential functions, logarithms, and limits, and applies them to a detailed study of differentiation and integration. Considerable time is spent on the applications of calculus to the fields of business, finance, and physics through the study of related rates, optimization, and analysis of curves and slopes. Students are also required to justify answers and conclusions using graphing calculators or *Microsoft Excel* spreadsheets and then effectively communicate their reasoning orally and in writing. Calculus provides students with the conceptual framework and analytical skills necessary for application to real-world problems and to be successful in the college calculus course.

Course Content

The Calculus course consists of the following units of study:

- **Functions and Their Graphs:** functions, function notation, domain and range, and functions as even or odd.
- **Limit of Functions:** continuity, one-sided and two-sided limits, and limit of slope of a secant line.
- **The Derivative:** rules for differentiation, higher-order derivatives, acceleration, velocity, and rate-of-change problems.
- **Graphing Functions Using Derivatives:** differentiability, concavity, absolute and local extrema, and points of inflection.
- **Applications of the Derivative:** related rates, optimization, physics, and economics-implicit differentiation, optimization of geometric and economic problems, and validation of possible solutions.
- **Applications of Exponential and Logarithmic Functions:** derivatives of exponential and logarithmic functions and derivatives of natural exponential and logarithmic functions.
- **Indefinite and Definite Integrals:** general and particular anti-derivatives, integral notation, techniques of integration, area under a curve, mean value theorem, and fundamental theorem of calculus.
- **Applications of the Definite Integral:** area between two curves and volumes of solids of revolution.

Course Objectives

The student will:

- employ higher-order mathematical symbolism and notation.
- determine the derivative and its connection to instantaneous rate of change.
- define integration and its connection to the accumulation of area under a curve.
- analyze the best means by which to solve a particular calculus problem.
- employ the processes required to solve calculus problems efficiently.
- determine the means by which answers can be validated.
- summarize the various calculus functions that can be performed on a graphing calculator.
- conclude how calculus can be applied to various non-mathematical fields of study.

Evaluation Process

A final average of 65% or better is required. Throughout the length of this course, students will be evaluated on the basis of:

- Unit Tests and Performance Assessments (60% of grade)
- Quizzes (40% of grade)
- Midterm Examination (10% of course grade for the year)
- Final Examination (10% of course grade for the year)

Somerville Public Schools

Reaching for Excellence

Calculus
Student Agreement

STUDENT NAME: _____
Last Name First Name

GRADE: _____

My signature below indicates that I have received my copy of the Somerville Public Schools Course Requirements for Calculus.

I acknowledge my responsibility to read and understand all of the information contained in the Calculus Course Requirements information and syllabus packet.

_____ _____
Student Signature Date

Note: Be sure to share the course requirements for Calculus with your parents.