Course Title: AP Calculus (AB)
Board Approval Date: 06/16/14
Credit / Hours: 1.5 credit
Reviewed Annually

Course Description:

AP Calculus (AB) is a course offered to students who have a 93 average or better *or* teacher recommendation. This course is designed for the highly motivated student with outstanding mathematical aptitude. Students will be expected to work at the college level in analytic geometry and calculus in preparation for the Advanced Placement Examination in May. If the student does not take the AP exam, the AP designation will be removed from the student's transcript.

*Students will need a TI-89 graphing calculator for this course.

Learning Activities / Modes of Assessment:

Large group instruction	Tests and Quizzes
Checklists / Teacher Observation	Small group work
Projects with Rubrics	Computer simulations
Homework Assignments	

Instructional Resources:

AP Edition Calculus of a Single Variable* (Brooks/Cole, Cengage Learning 2010)

Course Pacing Guide

Course: AP Calculus (AB)

Course Unit (Topic) (Days/Periods)	**Length of Instruction**
1. Unit #1 Functions and Graphs	10 days
2. Unit #2 Limits and Continuity	15 days
3. Unit #3 Derivatives	25 days
4. Unit #4 Applications of the Derivative	25 days
5. Unit #5 Integration	25 days
6. Unit #6 Transcendental Functions	25 days
7. Unit #7 Applications of the Integral	15 days
8. Unit #8 Review for AP Exam	30 days
Total Days	170 days

Curriculum: CCSD CURRICULUM PENNSYLVANIA
Course: AP Calculus (AB) Date: February 16, 2018

Topic: Unit 1 Functions and Graphs Days: 10
Subject(s): AP Calculus (AB) Grade(s): 11,12

Know:	Understand:	Do:	
Domain Range Intercepts Degree of a Polynomial Symmetry Composition Inverses Unit Circle Special Triangles Slope Transformations Periodic Functions Intersection	Real world phenomena can be modeled by using functions and their graphs. Having an understanding of a variety of functions and graphs allows us to solve problems in more situations that arise.	APC.1	The student will define and apply the properties of elementary functions, including algebraic, trigonometric, exponential, and composite functions and their inverses, and graph these functions, using a graphing calculator. Properties of functions will include domains, ranges, combinations, odd, even, periodicity, symmetry, asymptotes, zeros, upper and lower bounds, and intervals where the function is increasing or decreasing.

Curriculum: CCSD CURRICULUM PENNSYLVANIA

Course: Advanced Placement Calculus **Date:** September 15, 2010 ET

Topic: #1 Functions and Graphs **Days:** 10

Subject(s): Math **Grade(s):** 12th

Key Learning: **The graph of a function can be determined by its properties.**

Unit Essential Question(s):

How can the properties of a function be used to determine the shape of a graph?

Concept: **Properties of Functions**	**Concept:** **Algebra of Functions**	**Concept:** **Graphs of Functions**
2.9.11.J, 2.8.11.T, 2.5.11.B, 2.8.11.O, 2.6.11.F	2.8.11.L, 2.8.11.H, 2.5.11.C, M11.D.3.2.3, M11.D.1.1.1, M11.D.2.2.3, 2.9.11.G, 2.8.11.N	M11.D.1.1.1, 2.10.11.A, M11.D.4.1.1, 2.8.11.O, 2.8.11.N, 2.9.11.G, 2.2.11.F, 2.8.11.H, 2.8.11.Q
Lesson Essential Question(s): What are the properties that can be used to aid in graphing a function? (A)	**Lesson Essential Question(s):** How can we manipulate functions to use them in a variety of ways? (A)	**Lesson Essential Question(s):** What are the characteristics of the sine, cosine, and tangent curves? (A) What are the characteristics of polynomial, radical, exponential, logarithmic, and rational functions? (A)
Vocabulary: domain, range, intercepts, degree of a polynomial, symmetry	**Vocabulary:** composition, inverses, unit circle, special triangles	**Vocabulary:** slope, transformations, periodic functions, intersection

Curriculum: CCSD CURRICULUM | PENNSYLVANIA
Course: AP Calculus (AB) | Date: February 16, 2018

Topic: Unit 2 Limits and Continuity | Days: 15
Subject(s): AP Calculus (AB) | Grade(s): 11,12

Know:	Understand:	Do:	
Limit Oscillating Behavior Infinite Limit Asymptotic Behavior Continuous Discontinuous Removable Discontinuity Non-removable Discontinuity	The concept of a limit is required in order to advance further into the two main branches of calculus: derivatives and integrals. Determining the continuity of a function enables us to decide whether it may be differentiated or integrated.	APC.2	The student will define and apply the properties of limits of functions. Limits will be evaluated graphically and algebraically. This will include a) limits of a constant; b) limits of a sum, product, and quotient; c) one-sided limits; and d) limits at infinity, infinite limits, and non-existent limits. * *AP Calculus BC will include l'Hopital's Rule, which will be used to find the limit of functions whose limits yield the indeterminate forms: 0/0 and ∞/∞.
		APC.3	The student will use limits to define continuity and determine where a function is continuous or discontinuous. This will include a) continuity in terms of limits; b) continuity at a point and over a closed interval; c) application of the Intermediate Value Theorem and the Extreme Value Theorem; and d) geometric understanding and interpretation of continuity and discontinuity.
		APC.4	The student will investigate asymptotic and unbounded behavior in functions. This will include a) describing and understanding asymptotes in terms of graphical behavior and limits involving infinity; and b) comparing relative magnitudes of functions and their rates of change.

Curriculum: CCSD CURRICULUM PENNSYLVANIA

Course: Advanced Placement Calculus **Date:** September 15, 2010 ET

Topic: #2 Limits and Continuity **Days:** 15

Subject(s): Math **Grade(s):** 12th

Key Learning: **Find limits graphically, numerically, and analytically.**
Determine the continuity of a function.

Unit Essential Question(s):

What is the relationship between limits and continuity?

Concept: **Limits of Functions** M11.D.2.2.3, 2.2.11.F	**Concept:** **Asymptotic and Unbounded Behavior** M11.D.1.1.1, 2.8.11.C, 2.2.11.F	**Concept:** **Continuity** 2.2.11.F, M11.D.2.2.3
Lesson Essential Question(s): What are some of the difficulties that can arise when attempting to find the limit of a function? (A) How can a limit be found graphically? (A)	**Lesson Essential Question(s):** What are the analytical techniques which can be used to compute the limit of a function? (A) How can you determine the behavior of a function approaching a point where it is undefined? (A)	**Lesson Essential Question(s):** How can you prove that a function is continuous? (A) How can you identify the points at which a function is not continuous? (A)
Vocabulary: limit, oscillating behavior	**Vocabulary:** infinite limit, asymptotic behavior	**Vocabulary:** continuous, discontinuous, removable/ nonremovable discontinuity

Topic: Unit 3 Derivatives Days: 25
Subject(s): AP Calculus (AB) Grade(s): 11,12

Know:	Understand:	Do:	
Average Rate of Change Instantaneous Rate of Change Derivative Difference Quotient Local Linearity Power Rule Product Rule Quotient Rule Chain Rule Implicit Differentiation Velocity Acceleration Higher-Order Derivatives	Derivatives are used to determine rates of change of various functions. They have a number of applications in Physics and other areas of science.	APC.5	The student will investigate derivatives presented in graphic, numerical, and analytic contexts and the relationship between continuity and differentiability. The derivative will be defined as the limit of the difference quotient and interpreted as an instantaneous rate of change.
		APC.6	The student will investigate the derivative at a point on a curve. This will include a) finding the slope of a curve at a point, including points at which the tangent is vertical and points at which there are no tangents; b) using local linear approximation to find the slope of a tangent line to a curve at the point; c) defining instantaneous rate of change as the limit of average rate of change; and d) approximating rate of change from graphs and tables of values.
		APC.7	The student will analyze the derivative of a function as a function in itself. This will include a) comparing corresponding characteristics of the graphs of f, f', and f''; b) defining the relationship between the increasing and decreasing behavior of f and the sign of f'; c) translating verbal descriptions into equations involving derivatives and vice versa; d) analyzing the geometric consequences of the Mean Value Theorem; e) defining the relationship between the concavity of f and the sign of f'' and f) identifying points of inflection as places where concavity changes

		and finding points of inflection. APC.9 The student will apply formulas to find derivatives. This will include a) derivatives of algebraic, trigonometric, exponential, logarithmic, and inverse trigonometric functions; b) derivations of sums, products, quotients, inverses, and composites (chain rule) of elementary functions; c) derivatives of implicitly defined functions; and d) higher order derivatives of algebraic, trigonometric, exponential, and logarithmic, functions. *

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Course: Advanced Placement Calculus **Date:** September 15, 2010 ET

Topic: #3 Derivatives **Days:** 25

Subject(s): Math **Grade(s):** 12th

Key Learning: **Understand the relationship between a derivative, slope, and rate of change.**

Unit Essential Question(s):

What is the relationship between a derivative, slope, and rate of change?

Concept: **Definition of a Derivative** 2.2.11.F, M11.D.3.1.1, M11.C.3.1.2, 2.5.11.B	**Concept:** **Differentiation Techniques** 2.5.11.C, 2.5.11.B	**Concept:** **Higher Order Derivatives** 2.5.11.C
Lesson Essential Question(s): How can we calculate a derivative using its limit definition? (A) How can we apply the alternate form of the derivative to determine whether a function is differentiable? (A)	**Lesson Essential Question(s):** How can I calculate derivatives without using the definition? (A) How can we apply derivatives to the concepts of velocity and acceleration? (A) How can we use derivatives to solve Related Rates problems? (A)	**Lesson Essential Question(s):** What is the purpose of higher-order derivatives? (A)
Vocabulary: average rate of change, instantaneous rate of change, derivative, difference quotient, local linearity	**Vocabulary:** power rule, product rule, quotient rule, chain rule, implicit differentiation	**Vocabulary:** velocity, acceleration, higher-order derivatives

Curriculum: CCSD CURRICULUM | PENNSYLVANIA
Course: AP Calculus (AB) | Date: February 16, 2018

Topic: Unit 4 Applications of the Derivative | Days: 25
Subject(s): AP Calculus (AB) | Grade(s): 11,12

Know:	Understand:	Do:	
Relative Extrema Absolute Extrema Points of Inflection First Derivative Test Second Derivative Test Horizontal Asymptote Slant Asymptote Limits at Infinity Rolle's Theorem Mean Value Theorem Optimization Best-case Scenario Feasible Domain Critical Values Differential	Derivatives are used extensively in the fields of graph theory and optimization. A variety of engineering problems can be solved using derivatives.	APC.8	The student will apply the derivative to solve problems. This will include a) analysis of curves and the ideas of concavity and monotonicity; b) optimization involving global and local extrema; c) modeling of rates of change and related rates; d) use of implicit differentiation to find the derivative of an inverse function; e) interpretation of the derivative as a rate of change in applied contexts, including velocity, speed, and acceleration; and f) differentiation of nonlogarithmic functions, using the technique of logarithmic differentiation. *

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Course: Advanced Placement Calculus **Date:** September 15, 2010 ET

Topic: #4 Applications of Derivatives **Days:** 25

Subject(s): Math **Grade(s):** 12th

Key Learning: **Derivatives can be used to model real-life situations.**

Unit Essential Question(s):

Where can instantaneous rates of change be used?

Concept: **Using calculus to create accurate graphs of relations** 2.2.11.B, 2.2.11.C, 2.2.11.D, 2.5.11.A, 2.10.11.B, M11.D.3.1.1, M11.D.3.1.2, M11.D.3.2.1, 2.9.11.B	**Concept:** **Optimization** 2.2.11.D, 2.4.11.E, 2.5.11.A, 2.5.11.C, 2.5.11.D, 2.9.11.E	**Concept:** **Using the tangent line** 2.2.11.F, 2.5.11.A, 2.5.11.B, 2.8.11.R, 2.8.11.S, 2.8.11.T, 2.9.11.G, 2.11.11.A, 2.11.11.B, M11.C.3.1.2, M11.D.4.1.1
Lesson Essential Question(s): How can I find the relative and absolute extrema for a given relation? (ET) What calculus techniques can be used to accurately create the graph of a relation? (ET)	**Lesson Essential Question(s):** How can I use calculus to solve optimization problems in a variety of disciplines? (ET)	**Lesson Essential Question(s):** How can I use tangent lines to approximate values of nonlinear functions? (A) How can you use derivatives to identify increasing and decreasing intervals and concavity? (A)
Vocabulary: relative/absolute extrema, First/Second Derivative Tests, Horizontal/Slant Asymptotes, limits at infinity, Rolle's/Mean Value Theorems	**Vocabulary:** optimization, best-case scenario, feasible domain, critical values	**Vocabulary:** Newton's Method, iteration, differential, approximate change, actual change, percentage change, points of inflection

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Course: AP Calculus (AB) | Date: February 16, 2018

Topic: Unit 5 Integration | Days: 25
Subject(s): AP Calculus (AB) | Grade(s): 11,12

Know:	Understand:	Do:	
Riemann Sum Integral Trapezoidal Approximation Partition Upper and Lower Bounds Midpoint Rule Fundamental Theorem of Calculus U-substitution Change of Variables Power Rule Indefinite Integral Definite Integral	Integration is a process by which we can find an accumulation of rates of change. The process of integration is the inverse of differentiation. A variety of problems can be solved using the integral.	APC.10	The student will use Riemann sums and the Trapezoidal Rule to approximate definite integrals of functions represented algebraically, graphically, and by a table of values and will interpret the definite integral as the accumulated rate of change of a quantity over an interval interpreted as the change of the quantity over the interval $\int_a^b f'(x)\,dx = f(b) - f(a)$. Riemann sums will use left, right, and midpoint evaluation points over equal subdivisions.
		APC.11	The student will find antiderivatives directly from derivatives of basic functions and by substitution of variables (including change of limits for definite integrals). *
		APC.12	The student will identify the properties of the definite integral. This will include additivity and linearity, the definite integral as an area, and the definite integral as a limit of a sum as well as the fundamental theorem: $d/dx \int_a^x f(t)\,d(t) = f(x)$.
		APC.13	The student will use the Fundamental Theorem of Calculus to evaluate definite integrals, represent a particular antiderivative, and facilitate the analytical and graphical analysis of functions so defined.
		APC.14	The student will find specific antiderivatives, using initial conditions (including applications to motion along a line). Separable differential equations will be solved and used in modeling (in particular, the equation $y' = ky$ and exponential growth).

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Topic: #5 Integration **Days:** 25

Subject(s): Math **Grade(s):** 12th

Key Learning: **Integration can be described as the limit of the sum of quantities, or antidifferentiation.**

Unit Essential Question(s):

When is it appropriate to use a definite as compared to an indefinite integral?

Concept: **Properties of the Definite Integral** 2.2.11.B, 2.2.11.D, 2.11.11.D, 2.11.11.E	**Concept:** **Fundamental Theorem of Calculus** 2.2.11.F, 2.5.11.B	**Concept:** **Integration Techniques** 2.2.11.F, 2.5.11.B, 2.5.11.C
Lesson Essential Question(s): What are the different methods I can use to approximate the area under a curve? (A) What does a definite integral represent? (ET)	**Lesson Essential Question(s):** How is the Fundamental Theorem of Calculus used to compute a definite integral? (ET) How can the Fundamental Theorem of Calculus be used to compute the derivative of an accumulation function? (ET) For what applications should I use a definite integral? (ET)	**Lesson Essential Question(s):** How can I use substitution techniques to more easily calculate an integral? (A)
Vocabulary: Riemann Sum, Integral, Trapezoidal Approximation, Partition, Upper and Lower Bounds, Midpoint Rule	**Vocabulary:** Fundamental Theorem of Calculus	**Vocabulary:** u-substitution, change of variables, power rule

Curriculum: CCSD CURRICULUM | PENNSYLVANIA
Course: AP Calculus (AB) | Date: February 16, 2018

Topic: Unit 6 Transcendental Functions | Days: 25
Subject(s): AP Calculus (AB) | Grade(s): 11,12

Know:	Understand:	Do:
Logarithmic Function Exponential Function Inverse Trig Function Derivative of the Inverse Completing the square Slope Field Differential Equation Separation of Variables Initial Condition Particular Solution Exponential Growth and Decay General Solution Directly Proportional Inversely Proportional	Understanding transcendental functions gives us a broader set of skills for which we can solve problems for which we can use derivatives and integrals.	APC.9 The student will apply formulas to find derivatives. This will include a) derivatives of algebraic, trigonometric, exponential, logarithmic, and inverse trigonometric functions; b) derivations of sums, products, quotients, inverses, and composites (chain rule) of elementary functions; c) derivatives of implicitly defined functions; and d) higher order derivatives of algebraic, trigonometric, exponential, and logarithmic, functions. * APC.11 The student will find antiderivatives directly from derivatives of basic functions and by substitution of variables (including change of limits for definite integrals). * APC.13 The student will use the Fundamental Theorem of Calculus to evaluate definite integrals, represent a particular antiderivative, and facilitate the analytical and graphical analysis of functions so defined.

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Course: Advanced Placement Calculus **Date:** September 15, 2010 ET

Topic: #6 Transcendental Functions **Days:** 20

Subject(s): Math **Grade(s):** 12th

Key Learning: **We can use calculus to deal with transcendental functions.**

Unit Essential Question(s):

What are transcendental functions, and how can we find and use their derivatives and integrals?

Concept: **The calculus of transcendental functions** 2.2.11.F, 2.5.11.B, 2.5.11.C, 2.5.11.D	**Concept:** **Slope Fields** 2.4.11.A, 2.4.11.E, 2.5.11.B, 2.5.11.C	**Concept:** **Separable Differential Equations** 2.2.11.C, 2.2.11.F, 2.4.11.E, 2.5.11.A, 2.5.11.C, 2.6.11.C, 2.11.11.C
Lesson Essential Question(s): How do I calculate the derivatives of various transcendental functions? (A) How do I integrate various transcendental functions? (A)	**Lesson Essential Question(s):** How does an initial condition affect the solution to a differential equation? (A)	**Lesson Essential Question(s):** When and how can I apply the law of exponential growth and decay? (A) How can the law of exponential growth and decay be applied to authentic situations? (ET)
Vocabulary: logarithmic function, exponential function, inverse trigonometric function, derivative of the inverse, completing the square	**Vocabulary:** slope field, differential equation, direction field, separation of variables, initial condition, particular solution	**Vocabulary:** exponential growth/decay, Newton's Law of Cooling, general solution, family of functions, directly proportional

Topic: Unit 7 Applications of the Integral Days: 15
Subject(s): AP Calculus (AB) Grade(s): 11,12

Know:	Understand:	Do:
Irregular Shapes Area Under a Curve Area Between Two Curves Total Distance Traveled Displacement Disc Method Washer Method Volume of Cross-sectional solids Axis of Revolution Irregular Solid Average Value of a Function	Integration is a process that allows us to find the areas of irregular shapes and the volumes of irregular solids. The integral can also be used to find the average value of any given function.	APC.15 The student will use integration techniques and appropriate integrals to model physical, biological, and economic situations. The emphasis will be on using the integral of a rate of change to give accumulated change or on using the method of setting up an approximating Riemann sum and representing its limit as a definite integral. Specific applications will include a) the area of a region; b) the volume of a solid with known cross-section; c) the average value of a function; and d) the distance traveled by a particle along a line. *

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Course: Advanced Placement Calculus **Date:** September 15, 2010 ET

Topic: #7 Applications of Integration **Days:** 15

Subject(s): Math **Grade(s):** 12th

Key Learning: **The concept of integration can be applied to a variety of situations in the physical and social sciences.**

Unit Essential Question(s):

In what situations would it be appropriate to use integration?

Concept: **Area**	**Concept:** **Volume**	**Concept:** **Average Value of a Function**
2.2.11.B, 2.2.11.F, 2.4.11.E, 2.5.11.A, 2.5.11.B, 2.5.11.C, 2.5.11.D, 2.6.11.C, 2.8.11.R, M11.D.4.1.1	2.2.11.B, 2.2.11.C, 2.2.11.F, 2.4.11.E, 2.5.11.A, 2.5.11.B, 2.5.11.C, 2.5.11.D, 2.6.11.C, 2.8.11.R	2.2.11.C, 2.2.11.F, 2.4.11.E, 2.5.11.A, 2.5.11.B, 2.5.11.C, 2.5.11.D
Lesson Essential Question(s): How can an integral be used to find the area of an irregular shape? (A) What aspects of a function determine whether distance traveled and displacement are the same? (A) What is the difference between finding a definite integral and finding the area between two curves? (A)	**Lesson Essential Question(s):** How can I use an integral to find the volume of an irregular solid? (A)	**Lesson Essential Question(s):** How can I use an integral to find the average value of a function? (A)
Vocabulary: irregular shapes, area under a curve, area between two curves, total distance traveled, displacement	**Vocabulary:** Disc/Washer Method, Shell Method, cross-sections, axis of revolution, irregular solid	**Vocabulary:** Mean Value Theorem for integrals

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Topic: Unit 8 Review for AP Exam Days: 30
Subject(s): AP Calculus (AB) Grade(s): 11,12

Know:	Understand:	Do:
AP Test Format Calculator Inactive Multiple Choice Calculator Active Multiple Choice Calculator Inactive Free Response Calculator Active Free Response Grading Rubrics Scoring the AP Test	The AP Calculus Test is graded on a scale of 1 through 5. The test has a total of 108 possible points, split equally between a multiple choice and a free response section. There are 45 multiple choice and 6 free response questions. Understanding the grading rubrics and scoring guidelines can aid students in improving their scores.	Students will take the AP Exam on the assigned date and achieve a score of 3 or higher in order to receive college credit.