Mehlville School District

Advanced Placement Calculus

BOE Approval Required to Change

General Course Information

Course Name: Advanced Placement Calculus	
Department: Math	Grade Level(s): 11, 12
Duration/Credits: 1 year/ 1.0 credit math and available for Dual Credit	Prerequisites: Successful completion of Pre Calculus is required. Students should be proficient in applying algebraic operations to manipulate algebraic and trigonometric expressions, solving algebraic and trignometric equations, analyzing algebraic and trigonometric functions, and applying geometric relationships to solve problems.
BOE Approval Date: 12/19/19	Course Code: 2411W
Course Description:	
This course includes the study and application of continuity, limits, derivatives, the definite integral, techniques of integration and plane analytical geometry. Each student is required to have a scientific calculator (TI-84+ recommended). Dual Credit and Advanced Placement credit offered. See pages 10 and 11 for more information about Dual Credit and Advanced Placement fees.	
Course Rationale:	
The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase. Just as the level of mathematics needed for intelligent citizenship has increased, so too has the level of mathematical thinking and problem solving needed in the workplace. Those who can problem solve, think critically, and communicate will have significantly enhanced the opportunities and options for shaping their futures. Mathematical competence opens doors to productive futures. This course allows students to develop these problem solving, critical thinking, and communication skills within the context of higher level mathematical reasoning.	
Course Objectives:	

1. The student will calculate limits for function values and apply the properties of limits.
2. The student will identify the intervals upon which a function is continuous and understand the meaning of a continuous function.
3. The student will use the rules of differentiation to calculate derivatives, including second and higher order derivatives.
4. The student will read and solve application problems involving finding minimum or maximum values of functions and problems involving related rates. (A+ Reading)
5. The student will integrate functions using various techniques including the Fundamental Theorem of Calculus.
6. The student will use integration to calculate areas of regions in a plane and volumes of solids.
7. The student will provide mathematical arguments by verbally explaining solutions and critiquing the rationale of others. (A+ Speaking and Listening)
8. The student will research calculus topics and present findings written and verbally. (A+ Research and Writing)

Dual Credit

- Missouri Baptist University: Students who enroll in the dual credit course will receive 4 college credits for this course. Information on how to sign up will be given in class. The college course grade received will be an average of the two high school semester grades earned.
    - MBU Course title: MATH 164
- UMSL: Students who enroll in the dual credit course will receive 5 college credits for this course. Information on how to sign up will be given in class. The college course grade received will be an average of the two high school semester grades earned.
    - UMSL Course title: MATH 1800
- SLU: Students who enroll in the dual credit course will receive 4 college credits for this course. Information on how to sign up will be given in class. The college course grade received will be an average of the two high school semester grades earned.
    - UMSL Course title: Math 1510

Standards Alignment:

US: AP Calculus Standards (2019) from AP CollegeBoard
https://apstudents.collegeboard.org/sites/default/files/2019-05/ap-calculus-ab-bc-course-and-exam-description.pdf

Power Standards

List Standards -
EU1.1: The concept of the limit can be used to understand the behavior of functions.
EU1.2: Continuity is a key property of functions that is defined using limits.
EU2.1: The derivative of a function is defined as the limit of the difference quotient and can be determined using a variety of strategies.
EU2.2: A function's derivative can be used to understand the behavior of the function.
EU2.3: The derivative has multiple interpretations, and applications including those that involve instantaneous rates of change.
EU3.1: Antidifferentiation is the inverse process of differentiation.
EU3.2: The definite integral of a function over an interval is the limit of a Riemann sum over that interval and can be calculated using a variety of strategies.
EU3.3: The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.
EU3.4: The definite integral of a function over an interval is a mathematical tool with many interpretations and applications involving accumulation.

Unit I: Limits	**Duration:** 3-4 weeks
Unit Description: Conceptually, algebraically, and graphically interpret limits	
Unit Standards	**Key Learning Targets**
Reference *Essential Knowledge* from the CollegeBoard AP Document	• I can express limits symbolically using correct notation. • I can interpret limits expressed symbolically. • I can estimate limits of functions. • I can determine limits of functions. • I can deduce and interpret behavior of functions using limits. • I can analyze functions for intervals of continuity or points of discontinuity. • I can determine the applicability of important calculus theorems using continuity.
Essential Questions	**Enduring Understandings**
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?	The concept of understanding that a function converges to a numerical value. Students will be able to identify if and where a function is discontinuous. Calculus allows us to generalize knowledge about motion to diverse problems involving change.
Resources: Finney, Demana, Waits, Kennedy. Calculus – Graphical, Numerical, Algebraic, 3rd edition. Pearson Education/Prentice Hall, 2007.	
Previous knowledge and skills needed: Factoring, functions operations and graphing, rational function, conjugates, asymptotes	
Key Unit Vocabulary: Limit, Continuity, Rate of Change, Infinity, Asymptotes	

Unit II: Derivatives	**Duration:** 9-10 weeks
Unit Description: Find derivatives using limits, formulas and graphs	
Unit Standards	**Key Learning Targets**
Reference *Essential Knowledge* from the CollegeBoard AP Document	• I can identify the derivative of a function as the limit of a difference quotient. • I can recognize the connection between differentiability and continuity. • I can estimate derivatives. • I can calculate derivatives.I can apply implicit differentiation to find derivatives of multivariable functions. • I can determine higher order derivatives. • I can solve problems involving the slope of a tangent line.
Essential Questions	**Enduring Understandings**
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? Why do mathematical properties and rules for simplifying and evaluating limits apply to differentiation? 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	Derivative is the slope of the tangent line and the rate of change.

about the number of graduates at that level of investment?	
Resources: Finney, Demana, Waits, Kennedy. Calculus – Graphical, Numerical, Algebraic, 3rd edition. Pearson Education/Prentice Hall, 2007.	
Previous knowledge and skills needed: limits, equation of a line, trig with the unit circle, parallel and perpendicular lines	
Key Unit Vocabulary: derivative, product rule, quotient rule, chain rule, tangent line, normal line, slope, differentiation	

Unit III: Applications of Derivatives	**Duration:** 4-5 weeks
Unit Description: Using derivatives to solve applications involving related rates, optimization and motion	
Unit Standards	**Key Learning Targets**
Reference *Essential Knowledge* from the CollegeBoard AP Document	● I can use derivatives to analyze properties of a function. ● I can interpret the meaning of a derivative within a problem. ● I can solve problems involving related rates, optimization, and rectilinear motion.
Essential Questions	**Enduring Understandings**
How are problems about position, velocity, and acceleration of a particle in motion over time structurally similar to problems about the volume of a rising balloon over an interval of heights, the population of London over the 14th century, or the metabolism of a dose of medicine over time? What additional information is included in a sound mathematical argument about optimization that a simple description of an equivalent answer lacks?	Derivatives are used for finding related rates and optimization.
Resources: Finney, Demana, Waits, Kennedy. Calculus – Graphical, Numerical, Algebraic, 3rd edition. Pearson Education/Prentice Hall, 2007.	
Previous knowledge and skills needed: solving polynomials, solving rational functions, radicals,	
Key Unit Vocabulary: critical value, extrema, rate of change, velocity, acceleration, speed,	

<table>
<tr><td>Unit IV: Riemann and Fundamental Theorem of Calculus</td><td>Duration: 5-6 weeks</td></tr>
<tr><td colspan="2">Unit Description: Using Riemann sums to define the definite integral. Explain the Fundamental Theorem of Calculus.</td></tr>
<tr><td>Unit Standards</td><td>Key Learning Targets</td></tr>
<tr><td>Reference Essential Knowledge from the CollegeBoard AP Document</td><td>● I can interpret the definite integral as the limit of a Riemann sum.
● I can express the limit of a Riemann sum in integral notation.
● I can approximate a definite integral.
● I can calculate a definite integral using areas and properties of definite integrals.
● I can analyze functions defined by an integral.</td></tr>
<tr><td>Essential Questions</td><td>Enduring Understandings</td></tr>
<tr><td>Given information about a rate of population growth over time, how can we determine how much the population changed over a given interval of time?</td><td>Definite integrals can be approximated using geometric and numerical methods. The Fundamental Theorem of Calculus connects differentiation and integration.</td></tr>
<tr><td colspan="2">Resources: Finney, Demana, Waits, Kennedy. Calculus – Graphical, Numerical, Algebraic, 3rd edition. Pearson Education/Prentice Hall, 2007.</td></tr>
<tr><td colspan="2">Previous knowledge and skills needed: summation notation, limits, area of various geometric shapes</td></tr>
<tr><td colspan="2">Key Unit Vocabulary: Summation, Riemann sums, Rectangular approximation methods, Antiderivative, Simpson's Rule, Trapezoidal Rule</td></tr>
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Unit V: Integrals	**Duration:** 5-6 weeks
Unit Description:	
Unit Standards	**Key Learning Targets**
Reference *Essential Knowledge* from the CollegeBoard AP Document	● I can recognize antiderivatives of basic functions. ● I can calculate antiderivatives. ● I can evaluate definite integrals.
Essential Questions	**Enduring Understandings**
How is integrating to find areas related to differentiating to find slopes?	Recognizing opportunities to apply knowledge of geometry and mathematical rules can simplify integration.
Resources: Finney, Demana, Waits, Kennedy. Calculus – Graphical, Numerical, Algebraic, 3rd edition. Pearson Education/Prentice Hall, 2007.	
Previous knowledge and skills needed: derivatives, substitution, fractions, partial fractions,	
Key Unit Vocabulary: Antiderivative, U substitution, Integration by Parts, Definite and Indefinite Integrals	

Unit VI: Applications of Integrals	**Duration:** 4-5 weeks
Unit Description: Use integrals to find the area between two curves, find the volume of revolutions, force, define exponential growth and slope fields.	
Unit Standards	**Key Learning Targets**
Reference *Essential Knowledge* from the CollegeBoard AP Document	● I can interpret the meaning of a definite integral within a problem. ● I can apply definite integrals to problems involving the average value of a function. ● I can apply definite integrals to problems involving motion. ● I can apply definite integrals to problems involving area, volume, and length of a curve. ● I can use definite integral to solve problems in various contexts. ● I can interpret, create, and solve differential equations from problems in context.
Essential Questions	**Enduring Understandings**
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?	Solving differential equations allows us to determine functions and develop models. Definite integrals allow us to solve problems involving the accumulation of change over an interval. Definite integrals allow us to solve problems involving the accumulation of change in area or volume over an interval.
Resources: Finney, Demana, Waits, Kennedy. Calculus – Graphical, Numerical, Algebraic, 3rd edition. Pearson Education/Prentice Hall, 2007.	
Previous knowledge and skills needed: graphing functions, volume and area	

formulas of various geometric shapes, log and exponential functions
Key Unit Vocabulary: Volume of revolution, Slope field, Area Between Curve, Disk, Washer, Shell