School District of Marshfield Course Syllabus

Course Name: AP Calculus AB Honors
Length of Course: 1 Year
Credit: 1

Program Goal(s):

The School District of Marshfield Mathematics Program will prepare students for college and career in the 21st century by ensuring ***all*** students learn based on skills and knowledge needed to succeed in post-secondary education/training, career, and life. The 4K through High School Mathematics curriculum is designed to support every student in achieving success. Students will be placed in to the driver's seat. Innovative educators will tailor instruction to student need through engaging learning activities and relevant assessment.

Course Description:

AP Calculus AB is roughly equivalent to a first semester college calculus course devoted to topics in differential and integral calculus. The AP course covers topics in these areas, including concepts and skills of limits, derivatives, indefinite and definite integrals, applications of derivatives and integrals, slope-fields, and the Fundamental Theorem of Calculus. The course teaches students to approach calculus concepts and problems when they are represented graphically, numerically, analytically, and verbally, and to make connections amongst these representations. Students learn how to use technology to help solve problems, experiment, interpret results, and support conclusions.

RECOMMENDED PREREQUISITES: Before studying calculus, all students should complete the equivalent of four years of secondary mathematics designed for college-bound students: courses which should prepare them with a strong foundation in reasoning with algebraic symbols and working with algebraic structures. Prospective calculus students should take courses in which they study algebra, geometry, trigonometry, analytic geometry, and elementary functions. These functions include linear, polynomial, rational, exponential, logarithmic, trigonometric, inverse trigonometric, and piecewise defined functions. In particular, before studying calculus, students must be familiar with the properties of functions, the composition of functions, the algebra of functions, and the graphs of functions. Students must also understand the language of functions (domain and range, odd and even, periodic, symmetry, zeros, intercepts, and descriptors such as increasing and decreasing). Students should also know how the sine and cosine functions are defined from the unit circle and know the values of the trigonometric functions at the numbers 0, $\pi/6$, $\pi/4$, $\pi/3$, $\pi/2$, and their multiples.

Standards:	
Mathematical Practices	
Reasoning with Definitions and Theorems **[CR2a] -** The course provides opportunities for students to reason with definitions and theorems.	LO 1.2B - In problems where students practice applying the results of key theorems (e.g., Intermediate Value Theorem, Mean Value Theorems, and/or L'Hospital's Rule), students are required for each problem to demonstrate verbally and/or in writing that the hypotheses of the theorems are met in order to justify the use of the appropriate theorem. For example, in an in-class activity, students are given a worksheet that contains a set of functions on specified domains on which they must determine whether they can apply the Mean Value Theorem. There are cases where some of the problems do not meet the hypotheses in one or more ways. **[CR2a]**
Connecting Concepts and Processes **[CR2b] -** The course provides opportunities for students to connect concepts and processes. **[CR2d] -** The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.	LO 3.3A - Students are provided with the graph of a function and a second function defined as the definite integral of the graphed function with a variable upper limit. Using differentiation and antidifferentiation, students evaluate specific values of the second function and then find the intervals where the integral function is increasing, decreasing, concave up, and concave down. They use this information to sketch a rough graph of the second function. **[CR2b] [CR2d: graphical]**
Implementing Algebraic/ Computational Processes	LO 3.2B - Students are presented with a table of observations collected over time periods of different lengths (e.g., temperatures or stock prices). Students use

[CR2c] - The course provides opportunities for students to implement algebraic/computational processes. **[CR2d] -** The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them.	Riemann sums to numerically approximate the average value of the readings over the given time period and interpret the meaning of that value. **[CR2c] [CR2d: numerical]**
Connecting Multiple Representations **[CR2d] -** The course provides opportunities for students to engage with graphical, numerical, analytical, and verbal representations and demonstrate connections among them. **[CR3b] -** Students have opportunities to use calculators to solve problems.	LO 2.3C - Students are presented with numerous functions modeling velocity and time for objects in motion. These functions are presented numerically, graphically, analytically (in the form of a formula), and verbally (as a description in words of how the function behaves). Many of these functions are distinct, but some represent the same function (e.g., one of the functions presented verbally is the same as one of the functions presented analytically). Given some initial conditions, students calculate or approximate displacement, total distance travelled, and acceleration for these functions (both by hand and with a graphing calculator), and determine which representations are the same function. Students evaluate how each representation was useful for solving the problems. **[CR2d: connection between analytical and verbal] [CR3b]**
Building Notational Fluency **[CR2e] -** The course provides opportunities for students to build notational fluency. **[CR3c] -** Students have opportunities to use a graphing calculator to explore and interpret calculus concepts.	LO 3.5B - Students are given a variety of growth and decay word problems where the rate of change of the dependent variable is proportional to the same variable (e.g., population growth, radioactive decay, continuously compounded interest, and/or Newton's law of cooling). Students are asked to translate the problem situation into a differential equation using proper notation. Students show the steps in solving the differential equation, continuing to use proper notation for each step (e.g., when to keep or remove absolute value). In a later activity, students will vary initial conditions and use their calculators to graph the resulting solutions so that students can explore the effect of these changes. **[CR2e] [CR3c]**
Communicating **[CR2f]**—The course provides opportunities for students to communicate mathematical ideas in words, both orally and in writing.	Throughout the course, students are required to present solutions to homework problems both orally and on the board to the rest of the class. On at least one question on each quiz and test, students are explicitly instructed to include clearly written justifications in complete sentences for their solutions. **[CR2f]**
Curricular Requirements	
Limits and Continuity **[CR1a] -** The course is structured around the enduring understandings within Big Idea 1: Limits.	1. Evaluating limits a. Limits evaluated from tables b. Limits evaluated from graphs c. Limits evaluated with technology d. Limits evaluated algebraically i. Algebraic techniques ii. The Squeeze Theorem

	e. Limits that fail to exist 2. Limits at a point a. Properties of limits b. Two-sided limits c. One-sided limits 3. Continuity a. Defining continuity in terms of limits b. Discontinuous functions i. Removable discontinuity ii. Jump discontinuity iii. Infinite discontinuity c. Properties of continuous functions i. The Intermediate Value Theorem ii. The Extreme Value Theorem 4. Limits involving infinity a. Asymptotic behavior b. End behavior
Differential Calculus **[CR1b] -** The course is structured around the enduring understandings within Big Idea 2: Derivatives.	1. Introduction to derivatives a. Average rate of change and secant lines b. Instantaneous rate of change and tangent lines c. Defining the derivative as the limit of the difference quotient d. Approximating rates of change from tables and graphs 2. Relating the graph of a function and its derivative 3. Differentiability a. Relationship between continuity and differentiability b. When a function fails to have a derivative 4. Rules for differentiation a. Polynomial and rational functions b. Trigonometric functions c. Exponential and logarithmic functions d. Inverse trigonometric functions e. Second derivatives 5. Methods of differentiation a. The chain rule b. Implicit differentiation c. Logarithmic differentiation a. 6. Applications of derivatives a. Velocity, acceleration, and other rates of change b. Related rates c. The Mean Value Theorem **[CR1b: Mean Value Theorem]** d. Increasing and decreasing functions e. Extreme values of functions f. Local (relative) extrema g. Global (absolute) extrema h. Concavity i. Modeling and optimization j. Linearization

	k. Newton's method l. l. L'Hospital's Rule
Integral Calculus **[CR1c] -** The course is structured around the enduring understandings within Big Idea 3: Integrals and the Fundamental Theorem of Calculus.	1. Antiderivatives and indefinite integrals 2. Approximating areas a. The rectangle approximation method b. Riemann sums c. The trapezoidal rule 3. Definite integrals and their properties 4. The Fundamental Theorem of Calculus a. The First Fundamental Theorem of Calculus **[CR1c: Fundamental Theorem of Calculus part 1]** b. The Second Fundamental Theorem of Calculus **[CR1c: Fundamental Theorem of Calculus part 2]** c. The Mean Value Theorem for integrals d. Average value of a function 5. Methods of integration a. Algebraic manipulation b. Integration by substitution 6. Solving differential equations a. Separation of variables b. Slope fields 7. Applications a. Exponential growth and decay b. Particle motion c. Area between two curves d. Volumes i. Volumes of solids with known cross sections ii. Volumes of solids of revolution
Calculator **[CR3a] -** Students have access to graphing calculators.	A TI-84 Plus Graphing Calculator is required of all students. Use of the calculator by students to solve problems includes, but is not limited to, plotting and analyzing the graphs of functions within an arbitrary viewing window, finding the zeros of functions, finding the limit of a function at a specific value, and analytically and numerically calculating both the derivative of a function and the value of a definite integral. **[CR3a]** Another major use of graphing calculators is in labs to "discover" some of the concepts and principles at work by experimenting with the various function representations and approaches to their solutions. Calculator lab topics include the following: • Developing an intuitive understanding of limits • Investigating the Intermediate Value Theorem • Defining the slope of a function at a point by zooming in • Relationship between a function and its derivative • Linking up with the chain rule • Exploring exponentials

	• Newton's method • Riemann sums and the definite integral • Average value of a function • Numerical integration

Topics/Content Outline- Units and Themes:

Quarter 1:

- Limits and Continuity
- Differentiation

Quarter 2:

- Applications of Derivatives
- Introduction to Integration

Quarter 3:

- Methods/Applications of Integration
- Slope Fields

Quarter 4:

- More Applications of Integration
- Review for National AP Exam

Primary Resource(s):

Calculus: AP Edition- Graphical, Numerical, Algebraic, 5th Edition Prentice Hall ISBN: 0-13-331162-7 © 2016	Math XL, Pearson Realize