School District of Marshfield Course Syllabus

Course Name: Pre-Calculus AB Honors
Length of Course: 1 Year
Credit: 1

Program Goal:

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:

Prepare for AP Calculus AB (221). Emphasis will include: trigonometry, analytic geometry, behavior of mathematical functions, limits and elementary concepts of calculus.

PREREQUISITE: Algebra II H or instructor's recommendation

Standards:

Wisconsin Standards for Mathematical Practices (MP)	
MP: 1, 2, 3, 4, 5, 6, 7, 8	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically.

	6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
Wisconsin Standards for Mathematics- Number and Quantity	
The Complex Number System (N-CN)	
Perform arithmetic operations with complex numbers. N-CN: 1, 2, 3	1. Know there is a complex number i such that $i^2 = –1$, and every complex number has the form $a + bi$ with a and b real. 2. Use the relation $i^2 = –1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. 3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
Use complex numbers in polynomial identities and equations. N-CN: 7, 8, 9	7. Solve quadratic equations with real coefficients that have complex solutions. 8. (+) Extend polynomial identities to the complex numbers. *For example, rewrite* $x^2 + 4$ *as* $(x + 2i)(x – 2i)$. 9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.
Vector and Matrix Quantities (N-VM)	
Represent and model with vector quantities. N-VM: 1, 2	1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\boldsymbol{v}$, $\lvert\boldsymbol{v}\rvert$, $\lVert\boldsymbol{v}\rVert$, v). 2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
Perform operations on vectors. N-VM: 4a, 4b, 4c, 4d, 5a, 5b	4. (+) Add and subtract vectors. a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. c. Understand vector subtraction $\boldsymbol{v} – \boldsymbol{w}$ as $\boldsymbol{v} + (–\boldsymbol{w})$, where $–\boldsymbol{w}$ is the additive inverse of $\boldsymbol{w}$, with the same magnitude as $\boldsymbol{w}$ and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. 5. (+) Multiply a vector by a scalar. a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$. b. Compute the magnitude of a scalar multiple $c\boldsymbol{v}$ using $\lVert c\boldsymbol{v}\rVert = \lvert c\rvert v$. Compute the direction of $c\boldsymbol{v}$

	knowing that when $\|c\|v \neq 0$, the direction of $c\boldsymbol{v}$ is either along $\boldsymbol{v}$ (for $c > 0$) or against $\boldsymbol{v}$ (for $c < 0$).
Perform operations on matrices and use matrices in applications. N-VM: 6, 7, 8, 9, 10, 11	6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. 7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. 8. (+) Add, subtract, and multiply matrices of appropriate dimensions. 9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. 10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. 11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
Wisconsin Standards for Mathematics- Algebra	
Arithmetic with Polynomials and Rational Expressions (A-APR)	
Understand the relationship between zeros and factors of polynomials. A-APR: 2, 3	2. Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$. 3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
Use polynomial identities to solve problems. A-APR: 6, 7	6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system. 7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.
Reasoning with Equations and Inequalities (A-REI)	
Solve systems of equations. A-REI: 7, 9	7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line* $y = -3x$ and the circle $x^2 + y^2 = 3$.

	9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).
Wisconsin Standards for Mathematics- Functions	
Interpreting Functions (F-IF)	
Interpret functions that arise in applications in terms of the context F-IF: 6	6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
Analyze functions using different representations. F-IF: 7d, 7e, 8b	7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. 8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, *and classify them as representing exponential growth or decay.*
Building Functions (F-BF)	
Build new functions from existing functions. F-BF: 3, 4a, 4b, 4c, 4d, 5	3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. *Include recognizing even and odd functions from their graphs and algebraic expressions for them.* 4. Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. *For example,* $f(x) = 2x^3$ *or* $f(x) = (x+1)/(x–1)$ *for* $x \neq 1$. b. (+) Verify by composition that one function is the inverse of another. c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse. d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

	5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
Linear, Quadratic and Exponential Models (F-LE)	
Construct and compare linear, quadratic, and exponential models and solve problems. F-LE: 1c	1. Distinguish between situations that can be modeled with linear functions and with exponential functions. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
Trigonometric Functions (F-TF)	
Extend the domain of trigonometric functions using the unit circle. F-TF: 1, 2, 3, 4	1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. 2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. 3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi-x$, $\pi+x$, and $2\pi-x$ in terms of their values for x, where x is any real number. 4. Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.
Model periodic phenomena with trigonometric functions. F-TF: 5, 6, 7	5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. 6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. 7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.
Prove and apply trigonometric identities. F-TF: 8, 9	8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle. 9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
Wisconsin Standards for Mathematics- Geometry	
Similarity, Right Triangles and Trigonometry (G-SRT)	
Apply trigonometry to general triangles. G-SRT: 9, 10, 11	9. (+) Derive the formula $A = 1/2\ ab\ \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. 10. (+) Prove the Laws of Sines and Cosines and use them to solve problems. 11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Key Vocabulary:			
Symmetry	Symmetry with axes	Symmetry with origin	Symmetry with y = x
Operations on functions	Difference quotient of the function f(x)	Vertical line test	Odd and even functions
Increasing decreasing functions	Determining extrema	Average rate of change of a function	Slope of a secant
Piecewise-defined functions	Transformations	Shifts, stretches and shrinks	Regression Equations
Correlation coefficient	Multiplicity of a zero	End behavior	Oblique asymptote
Depressed equation	Fundamental Theorem of Algebra	Conjugate pairs	Composite functions
Inverse functions	Growth or decay functions	Financial models	Effective rates of return
Present value	Radians	Arc length	Area of a sector
Amplitude	Period	Phase shift	Trigonometric Identities
Principal values	Law of sines	Law of cosines	
Magnitude of a vector	Direction of a vector	Equal vectors	Opposite vectors
Perpendicular vectors	Augmented matrices	Coefficient matrices	Identity matrix
Inverse matrix	Partial fraction decomposition	Linear Programming	Limit of a function
One sided limits	Limits involving infinity		

Topics/Content Outline- Units and Themes:

Quarter 1:

- Families of graphs Part 1 (Linear, Quadratic, Cubic, Square Root, Cubic Root, Absolute Value, Power, Rational, and Step/Greatest Integer Functions)

Quarter 2:

- Families of graphs Part 2 (Exponential, Logarithmic, Logistic, Sine, Cosine)

Quarter 3:

- Trigonometry

Quarter 4:

- Vectors, Systems of Equations, Matrices, and Limits

Primary Resource(s):	
Precalculus: Graphical, Numerical, Algebraic Common Core, 10th Edition Addison-Wesley ISBN: 978-0-13-467209-0 © 2019	Math XL, Pearson Realize