# Hamilton-Wenham Regional School District

# HWRHS Common Core Standards <Precalculus A1>

## <Subject> Units

Unit 1 – Triangle Trigonometry with Vectors (Chapters 9 and 12)

Unit 2 – Trigonometric Functions (Chapter 7)

Unit 3 – Trigonometric Equations and Applications (Chapter 8)

Unit 4 – Trigonometric Addition Formulas (Chapter 10)

Unit 5 – Polar Coordinates and Complex Numbers (Chapter 11)

Unit 6 – Exponents and Logarithms (Chapter 5)

Unit 7 – Analytic Geometry (Chapter 6)

Unit 8 – Sequences and Series (Chapter 13)

Unit 9 – Rational Functions and Limits (Chapter 19)

## <Subject> Overview

Precalculus combines the trigonometric, geometric, and algebraic techniques needed to prepare students for the study of calculus, and strengthens students’ conceptual understanding of problems and mathematical reasoning in solving problems. Facility with these topics is especially important for students intending to study calculus, physics, other sciences, and/or engineering in college. *Advanced Mathematics: Precalculus with Discrete Mathematics and Data Analysis*, by Richard G. Brown (Houghton Mifflin, 1992), is used as a primary resource. Chapter and content numbers included in parentheses refer this textbook.

## <Subject> Prerequisites

Successful completion of Algebra 2 and Geometry

## Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 1>

## Conceptual Category

<Number and Quantity/Geometry>

### <Unit 1> <Triangle Trigonometry with Vectors> <15 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 1.1  (9-1) – solving right triangles  G-SRT8 | How much information do we need to know about a triangle in order to solve for all its side lengths and angle measures? | Definitions of sine, cosine, and tangent ratios relative to right triangles; Pythagorean Theorem; triangle angle sum is | (IA) review of Pythagorean Theorem and triangle angle sum  (IA) review of “sohcahtoa” and calculator use  (IA) definitions of six trigonometric ratios relative to right triangles |
| Unit 1.2  (9-2) – area of a triangle  G-SRT9 | How do we find the area of a triangle given SAS? | Conditions for triangle congruence; | (IA) derive  from |
| Unit 1.3  (9-3) – law of sines  G-SRT10 | How do we solve a triangle given ASA, AAS, or SSA? | Working with proportions | (IA) ambiguous case |
| Unit 1.4  (9-4) – law of cosines  G-SRT10 | How do we solve a triangle given SAS or SSS? | order of operations and using inverse operations to solve equations | (SA) units 1.1-1.4 |
| Unit 1.5  (12-1) – geometric representation of vectors  N-VM1  N-VM4  N-VM5 | What is a vector?  What is a scalar?  How do we perform basic operations on vectors? |  | (IA) discuss examples of vector and scalar quantities  (IA) move vectors using parallelogram method  (IA) summarize properties of vector addition and scalar multiplication |
| Unit 1.6  (12-2) – algebraic representation of vectors  N-VM2  N-VM4  N-VM5 | How do we use rectangular coordinates to perform vector operations? |  | (IA) demonstrate how properties vector addition and scalar multiplication apply to vectors expressed in component form |
| Unit 1.7  (9-5) – applications of trigonometry to navigation and surveying  G-SRT11  N-VM3 | How do we apply trigonometry and vectors to solve problems involving navigation, surveying, and resultant forces? | Diagonal of a polygon is a segment connecting non-consecutive vertices | (IA) measurement of angles from north clockwise  (SA) units 1.5-1.7 |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 1>

## Conceptual Category

<Functions>

### <Unit 2> <Trigonometric Functions> <15 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 2.1  (7-1) measurement of angles  F-TF1  F-TF2  F-TF4 | In trigonometry, how are angles measured?  What are coterminal angles? | Understanding of degree as an angle measure | (IA) trigonometric angle as a rotation of a ray about a point  (IA) converting between degree and radian angle measures |
| Unit 2.2  (7-3) the sine and cosine functions  F-TF3 | What are the sine and cosine functions?  How do we evaluate the sine and cosine functions? |  | (IA) evaluate sine and cosine expressions with and without a calculator  (IA) use Pythagorean Theorem to find sine or cosine ratios  (IA) discuss sign of sine and cosine in four quadrants |
| Unit 2.3  (7-4) evaluating and graphing sine and cosine  F-TF3  F-TF4 | What is a reference angle?  What is the unit circle and why is it useful?  What are some characteristics of the graphs of the sine and cosine functions? | Equation of a circle centered at the origin | (IA) unit circle with special right triangles  (IA) graph  and  (IA) use unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions  (SA) units 2.1-2.3 |
| Unit 2.4  (7-5) the other trigonometric functions  F-TF3  F-TF4 | What are the other trigonometric functions?  What are some characteristics of the graphs of the other trigonometric functions? |  | (IA) find values of the six trigonometric functions with and without a calculator  (IA) sketch graphs of the six trigonometric functions |
| Unit 2.5  (7-6) the inverse trigonometric functions  F-TF6  F-TF7 | How does an inverse trigonometric function differ from a trigonometric function? | Inverse functions as interchange of x and y | (IA) restrict a trigonometric function to a domain on which it is always increasing or always decreasing to allow for construction of inverse  (IA) find values of inverse trigonometric functions with and without the calculator  (IA) use inverse functions to solve trigonometric equations that arise in modeling contexts  (SA) units 2.4-2.5 |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 2>

## Conceptual Category

<Functions/Modeling>

### <Unit 3> <Trigonometric Equations and Applications> <15 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 3.1  (8-1) simple trigonometric equations  F-TF7 | What are some methods for solving simple trigonometric equations? | Solving linear equations with inverse operations | (IA) model solving simple trigonometric equations with and without the calculator |
| Unit 3.2  (8-2) sine and cosine curves  F-IF 7e | What is a sinusoidal?  How do we find the amplitude or period of a sinusoidal curve? |  | (IA) interactive or investigative activity to examine the impact of changing *A*, *B*, *h*, and *k* values of  or |
| Unit 3.3  (8-3) modeling periodic behavior  F-TF5 | How do we use trigonometric functions to model periodic behavior? |  | (SA) units 3.1-3.3 |
| Unit 3.4  (8-4) relationships among the functions | How are the trigonometric functions related to each other? | Knowledge of | (IA) prove the identity  and other Pythagorean relationships  (IA) investigate graphically relationships such as |
| Unit 3.5  (8-5) more difficult trigonometric equations  F-TF7 | What are some methods for solving more difficult trigonometric equations? | Solving quadratic equations by factoring and by the quadratic formula | (SA) units 3.4-3.5 |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 2>

## Conceptual Category

<Functions>

### <Unit 4> <Trigonometric Addition Formulas> <7 days>

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| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 4.1  (10-1) formulas for  and  F-TF9 | How do we derive the sum and difference formulas for sine and cosine?  How do we use these formulas to find exact values? |  | (IA) derive  from the law of cosines  (IA) demonstrate how to apply formulas to find exact values |
| Unit 4.2  (10-2) formulas for  F-TF9 | How do we derive and apply the sum and difference formulas for tangent? | Graphing linear functions from standard or slope-intercept form | (IA) demonstrate how to apply  formula to find the angle formed by the intersection of two lines |
| Unit 4.3  (10-3) double-angle and half-angle formulas  F-TF9 | How do we derive and apply double-angle and half-angle formulas? |  | (IA) derive double angle formulas from sum formulas |
| Unit 4.4  (10-4) solving trigonometric equations  F-TF9 | How do we use the identities to solve trigonometric equations? |  | (SA) units 4.1-4.4 |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 2>

## Conceptual Category

<Number and Quantity>

### <Unit 5> <Polar Coordinates and Complex Numbers> <8 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 5.1  (11-1) polar coordinates and graphs  N-CN4 | What are polar coordinates?  How do polar coordinates relate to rectangular coordinates?  How do we graph equations using polar coordinates? | Comprehension of rectangular coordinate plane; definitions of trigonometric functions; facility with unit circle | (IA) CARI – read pp. 395-399 of the text and answer the related questions [filename 11.1 cari]  (IA) model problems for graphing polar equations and converting between rectangular and polar coordinates  (IA) graphing calculator lab on polar graphs [from Portland State University course]  (FA) p400 #1-11 odd  (FA) p400 #13-21 odd, 24 |
| Unit 5.2  (11-2) geometric representation of complex numbers  N-CN3  N-CN4  N-CN5 | How do we use conjugates to find moduli and quotients of complex numbers?  How do we write complex numbers in polar form?  How do we find products in polar form? | Standard form of a complex number |  |
| Unit 5.3  (11-3) powers of complex numbers  N-CN5  N-CN6 | How do we use DeMoivre’s theorem to find powers of complex numbers? |  | (IA) calculate the distance between numbers in the complex plane as the modulus of the difference?  (IA) calculate the midpoint of a segment as the average of the numbers at its endpoints |
| Unit 5.4  (11-4) roots of complex numbers  N-CN8  N-CN9 | How do we find roots of complex numbers? |  | (IA) extend polynomial identities to the complex numbers  (IA) show that the Fundamental Theorem of Algebra is true for quadratic polynomials  (SA) units 5.1-5.4 |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 3>

## Conceptual Category

<Functions>

### <Unit 6> <Exponents and Logarithms> <15 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 6.1  (5-1) exponential growth and decay with integral exponents  F-BF1 | How and when do we apply exponential functions to growth and decay problems? | Laws of exponents; | (IA) review of laws of exponents  (IA) review of basic annual growth and decay function  (IA) model simplifying expressions with laws of exponents and without calculator |
| Unit 6.2  (5-2) exponential growth and decay with rational exponents  F-BF1 | When are rational exponents employed to growth and decay problems? | Definition of a rational exponent | (IA) model simplifying expressions with laws of exponents and without calculator  (IA) model solving equations with known bases by finding a common base  (IA) model solving equations with unknown base by raising both sides to reciprocal power |
| Unit 6.3  (5-3) exponential functions  F-BF1 | How do we define and effectively use different forms of exponential functions to solve problems? |  | (IA) model use of annual growth and decay function and “half-life” formula |
| Unit 6.4  (5-4) the number *e* and the function  F-BF1 | How do we define the number *e*?  When is the natural exponential function useful for solving problems? |  | (IA) investigate  (IA) discuss compound interest and continuous compounding of interest  (SA) units 6.1-6.4 |
| Unit 6.5  (5-5) logarithmic functions  F-BF4  F-BF5 | What is a logarithm?  How are logarithmic functions related to exponential functions? |  | (IA) define logarithm and its notation  (IA) discuss inverse relationship between logarithmic and exponential functions graphically and algebraically, include discussion of domain, range, and asymptotes |
| Unit 6.6  (5-6) laws of logarithms | How and when do we apply the laws of logarithms | Laws of logarithms | (IA) review laws of logarithms  (IA) use laws of logarithms to expand and condense logarithmic expressions  (IA) use laws of logarithms to solve equations |
| Unit 6.7  (5-7) changing bases to solve exponential equations  F-LE4 | How do we change bases to solve exponential equations? |  | (IA) discuss change of base formula  (SA) units 6.5-6.7 |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 3>

## Conceptual Category

<Geometry>

### <Unit 7> <Analytic Geometry> <15 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 7.1  (6-2) equations of circles  G-C4  G-GMD4 | How do we write the equation of a circle in center-radius form?  How do we identify points where circles and lines meet? | Equation of a circle centered at the origin as | (IA) geometric definition of a circle  (IA) discuss  (IA) solve systems of equations graphically and algebraically to determine if line intersects circle two times, is tangent to circle, or fails to intersect circle |
| Unit 7.2  (6-3) ellipses  G-GPE3  G-GMD4 | How do we derive equations of ellipses from the foci?  How might the ellipse be useful outside mathematics? | Distance formula | (IA) to visualize the geometric definition of an ellipse, visit <http://www.doublecrosseducation.com/fetc.htm>  (IA) write equations from graphs and draw graphs from equations  (FA) using geogebra software and worksheet ellipse 1 from <http://www.doublecrosseducation.com/fetc.htm>  (SA) units 7.1-7.2 |
| Unit 7.3  (6-4) hyperbolas  G-GPE3  G-GMD4 | How do we find equations of hyperbolas and graph hyperbolas?  How might the hyperbola be useful outside mathematics? |  | (IA) to visualize the geometric definition of a hyperbola, visit <http://www.doublecrosseducation.com/fetc.htm>  (FA) using geogebra software and worksheet hyperbola 1 from <http://www.doublecrosseducation.com/fetc.htm>  (IA) write equations from graphs and draw graphs from equations |
| Unit 7.4  (6-5) parabolas  G-GMD4 | How do we find equations of parabolas and graph parabolas?  How might the parabola be useful outside mathematics? | Familiarity with  and | (IA) to visualize the geometric definition of a parabola, visit <http://www.doublecrosseducation.com/fetc.htm>  (IA) write equations from graphs and draw graphs from equations  (FA) using geogebra software and worksheet parabola 1 from <http://www.doublecrosseducation.com/fetc.htm>  (SA) units 7.3-7.4  (SA) visit Desmos software at <https://www.desmos.com/> to create a computer drawing using graphs and equations of conic sections |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 4>

## Conceptual Category

<CHOOSE ONE: Number and Quantity/Algebra/Functions/Modeling/Geometry/Statistics and Probability>

### <Unit 8> <Sequences and Series> <15 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 8.1  (13-1) arithmetic and geometric sequences  F-IF3  F-BF2 | How do we identify arithmetic and geometric sequences?  How do we write explicit formulas for the  term of an arithmetic or geometric sequence | Familiarity with linear and exponential functions and their properties | (IA) define arithmetic and geometric sequences  (IA) find formulas for the  term of arithmetic and geometric sequences |
| Unit 8.2  (13-2) recursive definitions  F-IF3  F-BF2 | What does a recursive definition of a sequence involve?  How does a recursive definition compare to an explicit definition? |  | (IA) investigate recursive definitions using the Tower of Hanoi puzzle (p484 #31) |
| Unit 8.3  (13-3) arithmetic and geometric series and their sums  A-SS 4 | What is the difference between a sequence and a series?  How do we find the sum of the first *n* terms of an arithmetic or geometric series? |  | (IA) discuss formulas for the sum of a finite arithmetic series and a finite geometric series  (SA) units 8.1-8.3 |
| Unit 8.4  (13-4) limits of infinite sequences | How do we find or estimate the limit of an infinite sequence?  How do we determine that the limit of an infinite sequence does not exist? |  | (IA) investigate what values of *r* will lead to geometric sequences with a limit  (IA) examine sequences that have no limit or an infinite limit |
| Unit 8.5  (13-5) sums of infinite series | Is it possible to find the sum of an infinite number of numbers?  How do we find the sum of an infinite geometric series? |  | (IA) discuss sequence of partial sums, convergence, and divergence |
| Unit 8.6  (13-6) sigma notation | How do we represent a series using sigma notation? |  | (IA) define various parts of sigma notation and use sigma notation to represent series |
| Unit 8.7  (13-7) mathematical induction | What is induction?  How do we use mathematical induction to prove that a statement is true? |  | (IA) model proof by mathematical induction  (SA) units 8.4-8.7 |

# Common Core (CC) Standards Curriculum Map <Precalculus>

## <C. Campbell> <Quarter 4>

## Conceptual Category

<Algebra/Functions>

### <Unit 9> <Rational Functions and Limits> <15 days>

|  |  |  |  |
| --- | --- | --- | --- |
| CC Standard and Content | Mathematical Practices and Essential Questions | Prior Learning | Instructional Activities(IA)  Formative Assessments(FA)  Summative Assessments(SA) |
| Unit 9.1  (19-2) graphs of rational functions  F-IF7 | How do we efficiently and accurately sketch the graph of a rational function from its equation? | Familiarity with equations and graphs of rational functions, end behavior, and asymptotes | (IA) graph rational functions, identifying zeros, asymptotes, and removable discontinuities  (IA) discuss end behavior of graphs of rational functions using the concept of limit, end behavior notation, and limit notation |
| Unit 9.2  definition of a limit | What is a mathematical limit?  Can a limit ever be attained? |  | (IA) explore the definition of a limit graphically as two one-sided limits  (IA) provide a verbal description of the formal definition of a limit |
| Unit 9.3  (19-1) find limits of continuous and discontinuous functions | What does it mean for a function to be continuous at a point? |  | (IA) define continuity at a point  (IA) find limits of a function as *x* approaches infinity and as *x* approaches a specific value  (SA) units 9.1-9.3 |