### Course Title: Pre-Calculus 1AB

<table>
<thead>
<tr>
<th>Transcript Title:</th>
<th>Pre-Calculus 1AB</th>
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<tbody>
<tr>
<td>Grades Levels:</td>
<td>9-12</td>
</tr>
<tr>
<td>Board Adoption Date:</td>
<td>05/16/2015</td>
</tr>
<tr>
<td>GPA Scale:</td>
<td>4.0</td>
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<tr>
<td>Date Course Submitted:</td>
<td>05/16/2015</td>
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<tr>
<td>Credential Req:</td>
<td>SS Mathematics</td>
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<td>Graduation Subject Areas:</td>
<td>Math</td>
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<td>UC/CSU “A-G” Area Approvals:</td>
<td>C</td>
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<tr>
<td>School Site that wrote and submitted the course:</td>
<td>NHHS</td>
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<tr>
<td>Prerequisite(s):</td>
<td>Math III or Honors Enhanced Math III</td>
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<tr>
<td>Next course(s):</td>
<td>Calculus</td>
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</tbody>
</table>

#### COURSE DESCRIPTION (catalog summary):

The purpose of Pre-Calculus is to study the concepts from Math I, Math II, and Math III with greater depth and to continue to learn more advanced mathematical concepts and skills to prepare students for college level calculus. Students will be expected to have an understanding of theorems and concepts as well as their applications to the study of the real world. A particular goal is to improve their problem solving and critical thinking skills by requiring students to solve problems that are not simply procedural in nature or a match to problems studied previously. Pre-Calculus students will be taught how to understand mathematics verbally, analytically, numerically, and graphically and be able to present and teach others their knowledge with clarity and brevity. Students will study: power, polynomial, rational, exponential, and logarithmic functions, trigonometric identities, laws, and equations, systems of equations and matrices, conic sections, parametric equations, vectors, polar coordinates, complex numbers, and inferential statistics. Facility with these topics is especially important for students intending to study calculus, physics, and other sciences, and/or engineering in college. Because many of the standards for this course are (+) standards, students selecting this Pre-Calculus course should have met the college and career ready standards of the previous courses in the integrated pathway.

#### GOALS (expected performance outcomes for students):

Pre-Calculus course is comprised of standards selected from the high school conceptual categories: Modeling, Functions, Number and Quantity, Algebra, and Geometry. It is in the Pre-Calculus course that students pull together and apply the accumulation of learning that they have from their previous courses. The study of right triangle trigonometry expands to include general triangles. Students extend their work from a Math III course to investigate the reciprocal functions secant, cosecant, and cotangent and their graphs and properties. They find inverse trigonometric functions by appropriately restricting the domains of the standard trigonometric functions and use them to solve problems that arise in modeling contexts. Students extend their work with complex numbers to see that complex numbers can be represented in the Cartesian plane and that operations with complex numbers have a geometric interpretation. They connect their understanding of trigonometry and the geometry of the plane to express numbers in polar form. Students begin working with vectors, representing them geometrically and performing operations with them. They connect the notion of vectors to the complex numbers. Students also work with matrices and their operations, experiencing for the first time an algebraic system in which multiplication is not commutative. They see the connection between matrices and transformations in the plane, namely, that a vector in the plane can be multiplied by a 2x2 matrix to produce another vector, and they work with matrices from the point of view of transformations. They also find inverse matrices and use matrices to represent and solve linear systems. Students have worked previously with parabolas and circles, they now work with ellipses and hyperbolas. They also work with polar coordinates and curves defined parametrically, and connect these to their work with trigonometry and complex numbers. Students work with more complicated rational functions, graphing them and determining zeroes, y-intercepts, symmetry, asymptotes, intervals for which the function is increasing and decreasing, and maximum or minimum points. All prior experience with functions and geometry is brought together to create models and solve contextual problems. Embracing the growing importance of statistics in college work, the workplace, and life students...
will be introduced to information regarding data analysis, probability, and statistical literacy to prepare students for possible further study. The Mathematical Practice Standards apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations. The purpose is gain fluency in the language of mathematics and to appreciate mathematics usefulness in making sense of our world.

**CALIFORNIA COMMON CORE MATHEMATICS CONTENT STANDARDS AND MATHEMATICAL PRACTICES:**

Pre-Calculus Overview  
Number and Quantity  
The Complex Number System  
1. Perform arithmetic operations with complex numbers  
2. Represent complex numbers and their operations on the complex plane  
Vector and Matrix Quantities  
1. Represent and model with vector quantities  
2. Perform operation on vectors  
3. Perform operations on matrices and use matrices in applications  
Algebra  
Seeing Structure in Expressions  
1. Interpret the structure of expressions  
Arithmetic with Polynomials and Rational Expressions  
1. Rewrite rational expressions  
Creating Equations  
1. Create equations that describe numbers or relationships  
Reasoning with Equations and Inequalities  
1. Solve systems of equations  
Functions  
Interpreting Functions  
1. Interpret functions that arise in applications in terms of context  
2. Analyze functions using different representations  
Building Functions  
1. Build new functions from existing ones  
Trigonometric Functions  
1. Expand the domain of trigonometric functions using the unit circle  
2. Model periodic phenomena with trigonometric functions  
3. Prove and apply trigonometric identities  
Geometry
Similarity, Right Triangles, and Trigonometry
1. Apply trigonometry to general triangles

Expressing Geometric Properties with Equations
1. Translate between the geometric description and the equation for a conic section

Modeling with Geometry
1. Apply geometric concepts in modeling situations.

Statistics and Probability

Interpreting Categorical and Quantitative Data
1. Summarize, represent, and interpret data on a single count or measurement variable.

Making Inferences and Justifying Conclusions
1. Understand and evaluate random processes underlying statistical experiments.
2. Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

Using Probability to Make Decisions
1. Use probability to evaluate outcomes of decisions.

The Standards for Mathematical Practice apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations. The Standards for Mathematical Practice (MP) represent a picture of what it looks like for students to do mathematics in the classroom and, to the extent possible, content instruction should include attention to appropriate practice standards. The table below gives examples of how students can engage in the MP standards in Mathematics III.

<table>
<thead>
<tr>
<th>Standards for Mathematical Practice</th>
<th>Examples of each practice in Mathematics III</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MP1. Make sense of problems and persevere in solving them.</strong></td>
<td>Students apply their understanding of various functions to real world problems. They approach complex mathematics problems and break them down into smaller-sized chunks and synthesize the results when presenting solutions.</td>
</tr>
<tr>
<td><strong>MP2. Reason abstractly and quantitatively.</strong></td>
<td>Students deepen their understanding of variable, for example, by understanding that changing the values of the parameters in the expression $A\sin(Bx+C)+D$ has consequences for the graph of the function. They interpret these parameters in real world context.</td>
</tr>
</tbody>
</table>
Newport-Mesa Unified School District  
Office of Secondary Curriculum and Instruction  
High School Course of Study

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**MP3. Construct viable arguments and critique the reasoning of others.** Students build proofs by induction and proofs by contradiction. CA 3.1 (for higher mathematics only).

**MP4. Model with mathematics.** Students apply their new mathematical understanding to real world problems, making use of their expanding repertoire of functions in modeling. Students also discover mathematics through experimentation and examining patterns in data from real world contexts.

**MP5. Use appropriate tools strategically.** Students continue to use graphing technology to deepen their understanding of the behavior of polynomial, rational, square root, and trigonometric functions.

**MP6. Attend to precision.** Students make note of the precise definition of complex number, understanding that real numbers are a subset of the complex numbers. They pay attention to units in real world problems and use unit analysis as a method for verifying their answers.

**MP7. Look for and make use of structure.** Students understand the polynomials and rational numbers as sets of mathematical objects that have certain operations and properties. They understand the periodicity of sine and cosine and use these functions to model periodic phenomena.

**MP8. Look for and make use of regularity in repeated reasoning.** Students observe patterns in geometric sums, e.g. that the first several sums of the form \( \sum_{n=0}^{k} 2^n \) can be written:

\[
1 = 2^1 - 1; 1 + 2 = 2^2 - 1; 1 + 2 + 4 = 2^3 - 1; 1 + 2 + 4 + 8 = 2^4 - 1,
\]

and use this observation to make a conjecture about any such sum.

Common Core Standards Covered by Pre-Calculus
The Complex Number System N – CN
Perform arithmetic operations with complex numbers.
3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane.
4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.
5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, \((-1 + \sqrt{3} i) = 8 \) because \((-1 + \sqrt{3} i) \) has modulus 2 and argument 120°.
6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Vector and Matrix Quantities N – VM
Represent and model with vector quantities.
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., \( \vec{v}, |\vec{v}|, || \vec{v} ||, \vec{v} \)).
2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

Perform operations on vectors.
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 \( \vec{v} - \vec{w} \) as \( \vec{v} + (\vec{w}) \), where \( \vec{w} \) is the additive inverse of \( \vec{w} \), with the same magnitude as \( \vec{w} \) 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 \( c(\vec{v}_x, \vec{v}_y) = (c\vec{v}_x, c\vec{v}_y) \).
   b. Compute the magnitude of a scalar multiple \( cv \) using \( |cv| = |c||v| \). Compute the direction of \( cv \) knowing that when \( |c| \neq 0 \), the direction of \( cv \) is either along \( v \) (for \( c > 0 \) ) or against \( v \) (for \( c < 0 \) ).

Perform operations on matrices and use matrices in applications.
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.

12. (+) Work with $2 \times 2$ matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Conceptual Category: Algebra

**Seeing Structure in Expressions** A-SSE

Interpret the structure of expressions.

1. Interpret expressions that represent a quantity in terms of its context. ★
   a. Interpret parts of an expression, such as terms, factors, and coefficients.
   b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of $P$ and a factor not depending on $P$.

**Arithmetic with Polynomials and Rational Expressions** A-APR

Rewrite rational expressions.

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.

**Creating Equations** A-CED

Create equations that describe numbers or relationships

1. Create equations and inequalities in one variable including ones with absolute value and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. CA★

2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. ★

3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods. ★

4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm’s law $V = IR$ to highlight resistance $R$. ★
Reasoning with Equations and Inequalities A-REI
Solve systems of equations.
8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.
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 $3 \times 3$ or greater).

Conceptual Category: Functions

Interpreting Functions F-IF
Interpret functions that arise in applications in terms of the context.
4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.★
5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h$ gives the number of person-hours it takes to assemble $n$ engines in a factory, then the positive integers would be an appropriate domain for the function.★

Analyze functions using different representations.
7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★
7d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. CA★

Statistics and Probability
Summarize, represent, and interpret data on a single count or measurement variable. S-ID
1. Represent data with plots on the real number line (dot plots, histograms, box plots)
2. Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of the extreme data points.
4. Use the mean and standard deviation of the data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.★
5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data.
7. Interpret the slope and the intercepts of a linear model in the context of the data.
8. Compute with technology and interpret the correlation coefficient of a linear fit.
9. Distinguish between causation and correlation.

Making Inferences and Justifying Conclusions S-IC
1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
2. Decide if a specified model is consistent with the results from a data generating process.
3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
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</table>

5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
6. Evaluate reports based upon data.

**Conditional Probability and the Rules of Conditional Probability S-CP**

1. Describe events as subsets of a sample space using characteristics of the outcomes, or as unions, intersections, or complements of other events.
2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
3. Understand the conditional probability of A given B as P(A and B)/P(B) and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
4. Construct and interpret two way frequency tables of data when two categories are associated with each object being classified. Use the two way table as a sample space to decide if events are independent and to approximate conditional probabilities.
5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
6. Find the conditional probability of A given B as the fraction of B’s outcomes that also belong to A, and interpret the answer in terms of the model.
7. Apply the addition rule.
8+. Apply the general multiplication rule in a uniform probability model and interpret in terms of the model.
9+. Use permutations and combinations to compute probabilities of compound events and solve problems.

**Using Probability to Make Decisions S-MD**

1+. Define a random variable for a quantity on interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.
2+. Calculate the expected value of a random variable; interpret it as a the mean of the probability distribution.
3+. Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value.
4+. Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value.
5+. Weigh the possible outcomes of a decision by assigning probabilities of payoff value and finding expected values
   a. Find the expected payoff for a game of chance.
   b. Evaluate and compare strategies on the basis of expected values
6+. Use probabilities to make fair decisions.
7+. Analyze decisions and strategies using probability concepts.

**Building Functions F-BF**

Build new functions from existing functions.

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. (+) Verify by composition that one function is the inverse of another.
   b. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.
   c. (+) Produce an invertible function from a non-invertible function by restricting the domain.
Trigonometric Functions F-TF
Expand the domain of trigonometric functions using a unit circle.
4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Model periodic phenomena with trigonometric functions.
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.
9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
10. (+) Prove the half angle and double angle identities for sine and cosine and use them to solve problems. CA ★

Conceptual Category: Geometry

Similarity, Right Triangles, and Trigonometry G-SRT
Apply trigonometry to general triangles.
9. (+) Derive the formula \( A = \frac{1}{2} ab \sin(C) \) 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).

Expressing Geometric Properties with Equations G-GPE
Translate between the geometric description and the equation for a conic section.
3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
3.1 Given a quadratic equation of the form \( ax^2 + by^2 + cx + dy + e = 0 \), use the method for completing the square to put the equation in standard form; identify whether the graph of the equation is a circle, parabola, ellipse, or hyperbola, and graph the equation. CA

EVALUATION (how the effectiveness of the course will be monitored and assessed): Overall effectiveness will be determined by the scores earned by students taking the mathematics portion of the Smarter Balanced Assessment. Students will be assessed by district/teacher created end of unit summative tests and evaluated against a rubric. Students will also complete performance tasks periodically.
**Review of Prerequisite Skills: Unit 1**

This unit will review some of the skills studied in previous courses. Students will study the properties of algebra, equality, and inequalities. Students will use the distance and midpoint formulas. Students will write the equations of a circle and a line. Students will study the zero product property and the quadratic formula. Students can graph using a graphing utility. Students can complete the square and solve quadratic equations analytically. Students can solve absolute value and quadratic inequalities.

**Length of Unit ... 7 block periods**

<table>
<thead>
<tr>
<th>Key Vocabulary</th>
<th>Standards (referenced)</th>
<th>Model Tasks</th>
<th>Tools / Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichotomy property</td>
<td></td>
<td>See after unit 11 description.</td>
<td>Pre-Calculus: Enhanced with Graphing Utilities 3rd edition Chapter 1 pages 1-79, will be used as an additional resource for procedural, computational, modeling, and writing problems when the teacher deems it necessary to give students more opportunities to engage with the concepts and skills studied in the unit.</td>
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<tr>
<td>Properties of Algebra</td>
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<td></td>
<td></td>
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<tr>
<td>Distance</td>
<td></td>
<td></td>
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<tr>
<td>Midpoint</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Equation of a circle</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Properties of Equality and Inequalities</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Point Slope equation of a line</td>
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<tr>
<td>Quadratic Formula</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formula</td>
<td></td>
<td></td>
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<tr>
<td>Zero Product Property</td>
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</tbody>
</table>

**Differentiation**

**Support -- for students who are struggling with the content**

Content: Unit 1

Process: Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos

Product: Proficiency in Unit 1 content

**Extension -- for high achieving students.**

Content: Unit 1

Process: Robust and differentiated problem solving

Product: Solutions to real world and mathematical problems
### Evaluation

**Formative Assessments** (ongoing & mid-lesson):
Used to assess student understanding of Pre-Calculus common core standards in unit 1 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.

**Summative Assessments** (unit final evaluation):
Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.

### Unit 2

**Length of Unit … 13 block periods**

<table>
<thead>
<tr>
<th>Key Vocabulary</th>
<th>Standards (referenced)</th>
<th>Model Tasks</th>
<th>Tools / Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle in standard position</td>
<td>A.REI 11</td>
<td>See after unit 11 description.</td>
<td>Math III Irvine Math Project Unit 5 Trigonometry</td>
</tr>
<tr>
<td>Radian</td>
<td>F.BF 1, 1b, 4a</td>
<td></td>
<td>Pre-Calculus: Enhanced with Graphing Utilities Chapters 5 and 6 pages 367-475, will be used as an additional resource for procedural, computational, modeling, and writing problems when the teacher deems it necessary to give students more opportunities to engage with the concepts and skills studied in the unit.</td>
</tr>
<tr>
<td>Six Trigonometric Functions</td>
<td>F.LE 1, 2, 2.1, 5</td>
<td></td>
<td></td>
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<tr>
<td>Periodic Function</td>
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<td></td>
</tr>
<tr>
<td>Period, Amplitude, Phase Shift</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Arc length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit Circle</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
# Pre-Calculus 1AB

**Course Title**: Pre-Calculus 1AB  
**Course Code**: M0398-M0399

<table>
<thead>
<tr>
<th>Proportionality relationship of radian measure to locate points on concentric circles. Students will define sine and cosine on the unit circle in terms of angles of rotation measured in radians. Students will be introduced to the horizontal shifts of trigonometric functions in terms of a modeling context. Students will use trigonometric graphs and functions to model periodic behavior. Students will extend the definition of tangent of a right triangle trigonometric ratio to a function of an angle of rotation, including angles of rotation measured in radians on the circle. Students can classify sine, cosine and tangent functions as even or odd. Students will graph the cotangent, cosecant, and secant functions and explore the properties of these reciprocal functions.</th>
</tr>
</thead>
</table>
| Fundamental Trigonometric Identities  
Properties of all 6 Trigonometric Functions  
Sinusoidal and Other Trigonometric function graphs |

## Differentiation

**Support -- for students who are struggling with the content**

Content: **Unit 2**  
Process: *Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos*  
Product: *Proficiency in Unit 2 content*

**Extension – for high achieving students.**

Content: **Unit 2**  
Process: *Robust and differentiated problem solving*  
Product: *Solutions to real world and mathematical problems*
## Evaluation

**Formative Assessments** *(ongoing & mid-lesson):*

Used to assess student understanding of Pre-Calculus common core standards in unit 2 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.

**Summative Assessments** *(unit final evaluation):*

Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.

## Unit 3

**Length of Unit … 12 block periods**

<table>
<thead>
<tr>
<th>Key Vocabulary</th>
<th>Standards <em>(referenced)</em></th>
<th>Model Tasks</th>
<th>Tools / Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trigonometric Equations, Formulas and Inverses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trigonometric identities: product, sum, difference, half angle, double angle, product to sum, sum to product</td>
<td>F.TF 4+, 5+, 6+, 7+, 8+, 9+, 10+</td>
<td></td>
<td>Textbook: Pre-Calculus: Enhanced with Graphing Utilities 3rd edition Chapter 6 pages 457-525 will be used as a resource for procedural, computational, modeling, and writing problems when the teacher deems it necessary to give students more opportunities to engage with the concepts and skills studied in the unit. (Equivalent in 6th edition sections 7.1-7.7)</td>
</tr>
</tbody>
</table>

Students will be able to find the value expressions involving inverse sine, cosine, tangent, cotangent, secant, and cosecant. Students know the domains and ranges of the inverse trigonometric functions and can explain the reason for their restrictions. A student can use a calculator to evaluate inverse trigonometric expressions. Students can use known trigonometric identities to prove new ones. Students can use the sum, difference, double angle, half angle, product to sum, and sum to product formulas. Students will solve a variety of trigonometric equations: single trigonometric function, using identities, quadratic form, linear sine and cosine, using a graphing utility, restricted or unrestricted domains.

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### Course Title
Pre-Calculus 1AB

### Course Code
M0398-M0399

#### Differentiation

<table>
<thead>
<tr>
<th>Support -- for students who are struggling with the content</th>
<th>Content: Unit 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Process: Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos</td>
</tr>
<tr>
<td></td>
<td>Product: Proficiency in Unit 3 content</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Extension -- for high achieving students.</th>
<th>Content: Unit 3</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Process: Robust and differentiated problem solving</td>
</tr>
<tr>
<td></td>
<td>Product: Solutions to real world and mathematical problems</td>
</tr>
</tbody>
</table>

#### Evaluation

**Formative Assessments** (ongoing & mid-lesson):
Used to assess student understanding of Pre-Calculus common core standards in unit 3 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.

**Summative Assessments** (unit final evaluation):
Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.

#### Unit 4

**Length of Unit**: 9 block periods

<table>
<thead>
<tr>
<th>Key Vocabulary</th>
<th>Standards (referenced)</th>
<th>Model Tasks</th>
<th>Tools / Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modeling with Geometry</strong></td>
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<tr>
<td>Students will examine the relationship of sides in special right triangles. Students will develop strategies for solving non-right triangles. Students will examine the</td>
<td>Law of Sines</td>
<td>G.SRT 9+, 10+, 11+</td>
<td>See after unit 11 description.</td>
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<tr>
<td></td>
<td>Law of Cosines</td>
<td>G.GMD 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Area of a Triangle Formulas (SSS,</td>
<td>G.MG 1, 2, 3</td>
<td></td>
</tr>
</tbody>
</table>

Textbook: Mathematics Vision Project Module 5 Modeling with Geometry

http://www.mathematicsvisionproject.org/uploads/1/7/6/3/11636986/sec3_mod5_modgeo_se_041114.pdf

Pre-Calculus: Enhanced with Graphing Utilities
Law of Cosines and the Law of Sines. Students will find the missing sides, angles and area of general triangles.

<table>
<thead>
<tr>
<th>Support -- for students who are struggling with the content</th>
<th>Content: Unit 4</th>
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</thead>
<tbody>
<tr>
<td>Process: Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos</td>
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</tr>
<tr>
<td>Product: Proficiency in Unit 8 content</td>
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</tbody>
</table>

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
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</table>

**Formative Assessments** (ongoing & mid-lesson):
Used to assess student understanding of Pre-Calculus common core standards in unit 4 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.

**Summative Assessments** (unit final evaluation):
Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.
## Pre-Calculus 1AB

**Unit 5**

**Length of Unit**: 10 block periods

<table>
<thead>
<tr>
<th>Key Vocabulary</th>
<th>Standards (referenced)</th>
<th>Model Tasks</th>
<th>Tools / Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polar coordinates</td>
<td>N.CN 3+, 4+, 5+, 6+</td>
<td>See after unit 11 description.</td>
<td></td>
</tr>
<tr>
<td>Pole</td>
<td>F.IF 5</td>
<td></td>
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</tr>
<tr>
<td>Polar axis</td>
<td>N.VM 1+, 2+, 3+, 4abc+, 5ab+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polar form of a complex number</td>
<td></td>
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<tr>
<td>De Moivre’s Theorem</td>
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<tr>
<td>Nth root of a complex number</td>
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<tr>
<td>Vector</td>
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<tr>
<td>Position vector</td>
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<td></td>
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<tr>
<td>Unit vector</td>
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<td></td>
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<tr>
<td>Dot product</td>
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<td></td>
<td></td>
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<tr>
<td>Cross product</td>
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<td></td>
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<tr>
<td>Area of a parallelogram</td>
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</tbody>
</table>

**Polar Coordinates and Vectors**

Students will begin by plotting polar coordinates and converting between polar coordinates/equations and rectangular coordinates/equations. Students can identify polar equations and graph them by plotting points or using a graphing utility. Students can test the polar equations for symmetry. Complex numbers will be converted from rectangular form to polar form and plotted in the complex plane. Students will find the products and quotients of complex numbers in polar form and apply DeMoivre’s Theorem. Students can find complex roots. Students will be introduced to vectors and their applications to other sciences. Students can graph and add and subtract a vector. Students can find a position vector, unit vector, scalar product, and magnitude of a vector. Students can find a vector from its direction and magnitude. Students will solve problems of objects in static equilibrium. Students find the dot product, cross product or angle between two vectors. Determine whether two vectors are orthogonal or parallel. Students can decompose a vector into two orthogonal vectors and compute work. Finally, student will study vectors in 3D space.

Textbook:
Pre-Calculus: Enhanced with Graphing Utilities 3rd Edition Chapter 8 pages 581-659
will be used as a resource for procedural, computational, modeling, problem solving, and writing problems.
(Equivalent 6th edition section 9.1-9.7)
Students know algebraic and geometric properties of the cross product including area of a parallelogram and finding a vector orthogonal to two given vectors.

<table>
<thead>
<tr>
<th>Differentiation</th>
<th>Support -- for students who are struggling with the content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content: Unit 5</td>
<td>Process: Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos</td>
</tr>
<tr>
<td>Product: Proficiency in Unit 5 content</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extension – for high achieving students.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Content: Unit 5</td>
<td>Process: Robust and differentiated problem solving</td>
</tr>
<tr>
<td>Product: Solutions to real world and mathematical problems</td>
<td></td>
</tr>
</tbody>
</table>

### Evaluation

**Formative Assessments** (ongoing & mid-lesson):

*Used to assess student understanding of Pre-Calculus common core standards in unit 5 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.*

**Summative Assessments** (unit final evaluation):

*Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.*
<table>
<thead>
<tr>
<th>Unit 6: Systems of Equations, Inequalities, and Matrices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will solve systems of 3 equations containing three variables and identify inconsistent systems and dependent equations. Students can compute $2 \times 2$ and $3 \times 3$ determinants with and without a graphing utility. Students can solve $2$ and $3$ variable systems using Cramer’s rule. Students can compute sum, difference, and product of two matrices, the scalar multiple of a matrix, and the inverse of a $2 \times 2$ matrix. Students can compute the inverse of a $3 \times 3$ matrix with the aid of a graphing utility. Students can solve a system of equations using the inverse matrix. Students can compute the decomposition of rational expressions with non-repeated or repeated linear factors and quadratic irreducible factors. Students can solve systems of non-linear equations and inequalities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key Vocabulary</th>
<th>Standards (referenced)</th>
<th>Model Tasks</th>
<th>Tools / Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistent</td>
<td>N.VM 6+, 7+, 8+, 9+, 10+, 11+, 12+</td>
<td>See after unit 11 description.</td>
<td>Textbook: Pre-Calculus: Enhanced with Graphing Utilities 3rd edition Chapter 10 pages 740-757, 775-834 will be used as a resource for procedural, computational, modeling, problem solving and writing problems.</td>
</tr>
<tr>
<td>Inconsistent</td>
<td></td>
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</tr>
<tr>
<td>Determinant</td>
<td>A.REI 8+, 9+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cramer’s Rule</td>
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<tr>
<td>Dimension</td>
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<tr>
<td>Entry</td>
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<tr>
<td>Identity matrix</td>
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<tr>
<td>Matrix</td>
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<tr>
<td>Inverse of a Matrix</td>
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<tr>
<td>Augmented matrix</td>
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<tr>
<td>Partial fraction decomposition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solution to non linear system</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Scalar</td>
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</tbody>
</table>

### Differentiation

**Support -- for students who are struggling**

- **Content:** Unit 6
- **Process:** Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Pre-Calculus 1AB</th>
<th>Course Code</th>
<th>M0398-M0399</th>
</tr>
</thead>
</table>

| with the content     | Product: Proficiency in Unit 6 content                                           |             |             |
| Extension – for high achieving students. | Content: Unit 6 |             |             |
|                      | Process: Robust and differentiated problem solving                             |             |             |
|                      | Product: Solutions to real world and mathematical problems                     |             |             |

**Evaluation**

- **Formative Assessments** (ongoing & mid-lesson):
  - Used to assess student understanding of Pre-Calculus common core standards in unit 6 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.

- **Summative Assessments** (unit final evaluation):
  - Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.

**Unit 7**

- **Length of Unit**: 8 block periods

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<tr>
<th>Key Vocabulary</th>
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<th>Model Tasks</th>
<th>Tools / Texts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>S-ID 1-5, 7-9</td>
<td>See after unit 11 description.</td>
<td>Textbook: The Practice of Statistics Sections 1.1, 1.2, 2.1, 2.2, 3.1, 3.2, 5.1, 5.2, 6.1, 6.2, 6.3</td>
</tr>
<tr>
<td>Independent events</td>
<td>S-IC 1-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional probability</td>
<td>S-CP 1-7, 8+, 9+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>S-MD 1+, 2+, 3+, 4+, 5+, 6+, 7+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td>68-95-99.7 Rule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Title</td>
<td>Pre-Calculus 1AB</td>
<td>Expected value</td>
<td>Multiplication and Addition Principles of Probability</td>
</tr>
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<td>---------------------------------------------------</td>
</tr>
</tbody>
</table>

**Course Title**: Pre-Calculus 1AB

- Expected value
- Multiplication and Addition Principles of Probability
- Outlier
- Experimental design principles
- Correlation
- 5 number summary
- Shape, center, spread
- Skew
- Bimodal, unimodal
- Frequency distribution

**Differentiation**

**Support -- for students who are struggling with the content**

- Content: Unit 7
- Process: Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos
- Product: Proficiency in Unit 7 content

**Extension -- for high achieving**

- Content: Unit 7
- Process: Robust and differentiated problem solving

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**Newport-Mesa Unified School District**

**Office of Secondary Curriculum and Instruction**

**High School Course of Study**

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# Pre-Calculus 1AB

**Course Title:** Pre-Calculus 1AB  
**Course Code:** M0398-M0399

**Evaluation**

| Product | Solutions to real world and mathematical problems |

**Formative Assessments (ongoing & mid-lesson):**

Used to assess student understanding of Pre-Calculus common core standards in unit 8 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.

**Summative Assessments (unit final evaluation):**

Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.

## Unit 8

**Length of Unit** … 8 block periods

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<tbody>
<tr>
<td><strong>Conics</strong></td>
<td></td>
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<tr>
<td>Parabola</td>
<td>G-GPE 1, 2, and 3+</td>
<td>See after unit 11 description.</td>
<td>Textbook: Pre-Calculus: Enhanced with Graphing Utilities 3rd edition Chapter 9 pages 661-701 will be used as a resource for procedural, computational, modeling, problem solving and writing problems.</td>
</tr>
<tr>
<td>Ellipse</td>
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<td>Hyperbola</td>
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<td>Vertex</td>
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<td>Center</td>
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<td>Focus</td>
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<tr>
<td>Asymptote</td>
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<tr>
<td>Eccentricity</td>
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</table>

**Differentiation**

**Support -- for students who are struggling with the**

Content: *Unit 8*

Process: *Intervention units, flexible grouping, organizers, and instructional support beyond regular class time, instructional videos*
Newport-Mesa Unified School District  
Office of Secondary Curriculum and Instruction  
High School Course of Study

<table>
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<tr>
<td>content</td>
<td>Product: Proficiency in Unit 8 content</td>
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<td></td>
</tr>
</tbody>
</table>
| Extension – for high achieving students. | Content: Unit 8  
Process: Robust and differentiated problem solving  
Product: Solutions to real world and mathematical problems |             |             |

**Evaluation**

**Formative Assessments** (ongoing & mid-lesson):  
Used to assess student understanding of Pre-Calculus common core standards in unit 8 and the application of the mathematical practices to determine whether to move forward with lessons or to reteach. Strategies may include, but are not limited to informal checking for understanding, quizzes, performance tasks, and homework review.

**Summative Assessments** (unit final evaluation):  
Typically used to assess student achievement at the end of the unit. Strategies include but are not limited to, district wide unit tests, Smarter Balanced Assessments, a final exam, and a modeling performance task.

---

**Unit 1 Open Response or Performance Task**

Maddie and Clyde wanted some peace and quiet. Most of all, they wanted privacy. So they left the city and bought a piece of land out in the countryside. They thought what they bought was in the shape of a circle. They decided to plant an orchard on this lot in nice neat rows. First, they planted their first row along an east-west line through the center of the circle. The trees were equally spaced, except that they left out the tree that would have been located at the exact center of the circle. (This is where there home would be). There were 50 trees to the east of the center and 50 to the west. The trees at the ends of these east-west rows were exactly on the boundary of their property. They planted a north-south line of trees through the center, using the same spacing as before and omitting the tree at the center. Again, there were 50 trees to the north of the center and 50 to the south. The trees at the ends of this north-south row were exactly on the boundary of their property. They used each of the trees in their north-south row as the center of an east-west row, filling in the orchard with rows of trees. They always used the same distance between trees in every row. Maddie and Clyde realized that if the trees kept growing, the tree trunks would eventually become so big that it would become impossible to see out from the center of the orchard. As a group, (Construct viable arguments and critique the reasoning of others) use the information below (Look for and make use of structure) to answer the following question: "How soon after they planted the orchard would the center of the lot become a true "hideout"?" Be sure to provide enough evidence to convince the reader of your answer.

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Mathematical Practices Addressed: MP 1 Make sense of problems and persevere in solving them. MP 3 Construct viable arguments and critique the reasoning of others. MP 7 Look for and make use of structure. MP 6 Attend to precision.

Unit 2 Open Response Task

Example 1 – CBL Experiment

Using a CBL, the microphone probe and tuning fork, record the amplitude, frequency, and period of the sound form the graph of the sound created by the tuning fork over time. Write an equation that models the sound form of the graph displayed. Repeat this for multiple tuning forks.

Mathematical Practices Addressed: **MP4. Model with mathematics.** Students apply their new mathematical understanding to real world problems, making use of their expanding repertoire of functions in modeling. Students also discover mathematics through experimentation and examining patterns in data from real world contexts. **MP5. Use appropriate tools strategically.** Students continue to use graphing technology to deepen their understanding of the behavior of polynomial, rational, square root, and trigonometric functions.

Unit 3 Open Response Task

In this project you will use a Calculator Based Ranger, a graphing calculator, and swinging pendulums to collect data on the motion of a pendulum. You will collect data on the distance and time for the swinging pendulum and then find a mathematical model that describes the motion of the pendulum. Write the models in both sine and cosine form.

Mathematical Practices Addressed: **MP4. Model with mathematics.** Students apply their new mathematical understanding to real world problems, making use of their expanding repertoire of functions in modeling. Students also discover mathematics through experimentation and examining patterns in data from real world contexts. **MP5. Use appropriate tools strategically.** Students continue to use graphing technology to deepen their understanding of the behavior of polynomial, rational, square root, and trigonometric functions.

Unit 4 Open Response Tasks

Example 1

Jim and Barbara are house hunting and need to estimate the size of an irregular adjacent lot that is described by the owner as “a little more than an acre.” With Barbara stationed at a corner of the plot, Jim starts at another corner and walking a straight line towards her, counting his paces. They then shift corners and Jim paces again, until they have recorded the dimensions of the lot (in paces). See figure. What is the approximate acreage of the lot?
Mathematical Practices Addressed: **MP 1 Make sense of problems and persevere in solving them.** Students analyze what is given to explain to themselves the meaning of the problem. **MP 3 Students will justify their conclusions with mathematical ideas.** **MP 4 Model with mathematics.** Students will interpret the results of a mathematical situation.

Example 2 Writing Task
Show that there are infinitely many triangles with AAA given if the sum of the three positive angles is 180 degrees. Give three examples of triangles where the angles are 30 degrees, 60 degrees, and 90 degrees.

Mathematical Practices Addressed: **MP 3 Construct viable arguments and critique the reasoning of others.** Students will justify their conclusions with mathematical ideas.

Example 3 Group Task
A Ferris wheel has 16 evenly spaced cars. The distance between adjacent cars is 15.5 feet. Find the radius of the wheel.

Mathematical Practices Addressed: **MP 1 Make sense of problems and persevere in solving them.** Students analyze what is given to explain to themselves the meaning of the problem. **MP 3 Students will justify their conclusions with mathematical ideas.** **MP 4 Students will interpret the results of a mathematical situation.**

**Unit 5 Group Activity Tasks**
Example 1 A ship heads due south with the current flowing northwest. Two hours later the ship is 20 miles in the direction 30 degrees west of south from the original starting point. Find the speed with no current of the ship and the rate of the current.
Example 2 Prove that the sum of the squares of the diagonals of a parallelogram is equal to the sum of the squares of its sides.
Example 3 Explain how the graphs of $r = f(\theta)$, $r = f(\theta + \alpha)$, $r = f(\theta - \alpha)$ are related. Explain why you think this generalization is true.

Mathematical Practices Addressed: **MP 1 Make sense of problems and persevere in solving them.** Students analyze what is given to explain to themselves the meaning of the problem. **MP 3 Students will justify their conclusions with mathematical ideas.**

**Unit 6 Writing Tasks**
Example 1 If the products of $AB$ and $BA$ are defined for the nxm matrix $A$, what can you conclude about the order of matrix $B$? Explain.
Example 2 Explain why adding one row to another row in a matrix is an elementary row operation.
Example 3 Explain why the definition given for a square matrix agrees with the definition given for the determinant of a 2x2 matrix.

Mathematical Practices Addressed: **MP 3 Construct viable arguments and critique the reasoning of others.** Students will justify their conclusions with mathematical ideas.
Unit 7 Open Response Task
Popcorn
Many students like to eat microwave popcorn as they study for the ACT. Microwave popcorn producers assume that the time it takes for a kernel to pop is distributed normally with a mean of 120 seconds and a standard deviation of 13 for a standard microwave oven. If you’re a devoted popcorn studier, you don’t want a lot of un-popped kernels, but you know that if you leave the bag in long enough to be sure that all the kernels are popped, some of the popcorn will burn. How much time would you recommend for microwaving the popcorn? Use a normal distribution curve and the features of a normal distribution to explain your answer.

Mathematical Practices Addressed: MP 1 Make sense of problems and persevere in solving them. Students analyze what is given to explain to themselves the meaning of the problem. MP 3 Construct viable arguments and critique the reasoning of others. Students will justify their conclusions with mathematical ideas. MP 4 Students will interpret the results of a mathematical situation.

Unit 8 Open Task Response
Example 1 – Constructing a Bridge over the East River
A new bridge is to be constructed over the East River in NYC. The space between the supports needs to be 1050 ft; the height of the center of the arch needs to be 350 ft. Two structural possibilities exist: the support could be in the shape of a parabola or the support could be in the shape of a semi-ellipse. An empty tanker needs a 280 ft clearance to pass beneath the bridge. The width of the channel for each of the two plans must be determined to verify that the tanker can pass through the bridge.

a. Determine the equation of a parabola with these characteristics.
b. Determine the equation of the ellipse with these characteristics.
c. How wide is the channel that the tanker passes through in each case.
d. If the river were to flood and rise 10 feet, how would the clearances be changed for the two bridges. Does the affect the design you will choose. Which design are you going to choose and justify your choice.

Mathematical Practices Addressed: MP4 Students apply their new mathematical understanding to real world problems, making use of their expanding repertoire of functions in modeling. Students also discover mathematics through experimentation and examining patterns in data from real world contexts. MP 7 Look for the overall structures and patterns in mathematics. MP 8 Look for generalizations and short cuts. Explain how their strategies apply to other situations. MP 6 Communicate precisely with other students and use clear mathematical language when discussing their generalizations. MP 3 Listen to the arguments of others and ask useful questions to determine if their generalizations are correct. MP 1 Monitoring their own approach and changing if necessary.
Instructional Methods and/or Strategies

Students will experience a variety of instructional strategies within each unit. The students will use discovery and experimentation to investigate new material and make conjectures. For example, students may be asked to place graphs of functions into categories and make conjectures as to why they grouped them the way they did (MP 1, MP 2, MP 3, MP 7, MP 8). Group and individual presentations will be used for the student to report their findings to the class and allow students to learn from each other (MP 2, MP 3). Students will present the processes that lead to solutions and the reasoning behind the solutions. Students will have experiences in oral and written communication and receive feedback from their peers and teacher. Direct instruction will be used when a topic or skill needs to be explicitly shown or modeled. To be mathematically capable, students must have a facility with the basic techniques of mathematics. There are necessary skills and knowledge that students will routinely exercise without hesitation. Students will be responsible for working together and individually to accomplish tasks. For example, students may work together in cooperative learning groups when using measurement and data collection to analyze real life data, but may be asked to report their findings as an individual or as a group (MP 2, MP 3, MP 4, MP 6). Students will be taught to use technology such as calculators, internet access, and other mathematical software (MP 5) to help derive solutions to linear equations, systems of equations and inequalities, linear regression, scatter plots, and exponential functions. Modeling will be used to help students integrate topic from many units (MP 1). There will be guided practice called Set Problems so that students can learn to understand how they can use the skills or knowledge they learned. Daily Go Problems will be used to continuously integrate, spiral and review material.

Teaches will use a variety of instructional methods that may include:

- modeling mathematical thinking
- visual and graphic descriptions of problems
- systematic and explicit instructions
- student think-aloud
- using hands-on projects and learning activities
- use of structured peer-assisted learning activities involving heterogeneous ability groupings
- problem based learning and problem solving
- determine what they know by identifying what is known, what needs to be find out, what they want to learn based on a given case study scenario
- develop a problem statement which contains steps for solving the problem and factors for determining successful completion
- gather information through online resources, surveys, interviews, observations, measurements, etc.
- develop possible solutions using concept maps, Venn diagrams, graphic organizers, etc.
- presentations for students to demonstrate a solution to the case study based on what was learned
- use graphing calculators (TI-84+ family and TI-Nspire family)
The following is a summary of the eight MP standards and provides examples of questioning strategies teachers use to support mathematical thinking and student engagement as called for in the MP standards.

MP 1 Make sense of problems and persevere in solving them.
• Interpret and make meaning of the problem to find a starting point.
• Analyze what is given in order to explain to themselves the meaning of the problem.
• Plan a solution pathway instead of jumping to a solution.
• Monitor their own progress and change the approach if necessary.
• See relationships between various representations.
• Relate current situations to concepts or skills previously learned and connect mathematical ideas to one another.
• Continually ask themselves, “Does this make sense?”
• Can understand various approaches to solutions.
• How would you describe the problems in your own words?
• How would you describe what you are trying to find?
• What do you notice about...?
• What information is given in the problem?
• Describe the relationship between the quantities.
• Describe what you have already tried. What might you change?
• Talk me through the steps you’ve used to this point.
• What steps in the process are you most confident about?
• What are some other strategies you might try?
• What are some other problems that are similar to this one?
• How might you use one of your previous problems to help you begin?
• How else might you organize...represent...show...?

MP 2 Reason abstractly and quantitatively.
• Make sense of quantities and their relationships.
• Decontextualize (represent a situation symbolically and manipulate the symbols) and contextualize (make meaning of the symbols in a problem) quantitative relationships.
• Understand the meaning of quantities and flexibly flexible use operations and their properties.
• Create a logical representation of the problem.
• Attend to the meaning of quantities, not just how to compute them.
• What do the numbers used in the problem represent?
• What is the relationship of the quantities?
• How is _______related to _______?
• What is the relationship between _______ and _______?
• What does_______mean to you? (e.g. symbol, quantity, diagram)
• What properties might we use to find a solution?
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- How did you decide in this task that you needed to use...?
- Could we have used another operation or property to solve this task? Why or why not?

MP 3 Construct viable arguments and critique the reasoning of others.
- Analyze problems and use stated mathematical assumptions, definitions, and established results in constructing arguments.
- Justify conclusions with mathematical ideas.
- Listen to the arguments of others and ask useful questions to determine if an argument makes sense.
- Ask clarifying questions or suggest ideas to improve/revise the argument.
- Compare two arguments and determine correct or flawed logic.
- What mathematical evidence would support your solution?
- How can we be sure that...? or How could you prove that...?
- Will it still work if...?
- What were you considering when...?
- How did you decide to try that strategy?
- How did you test whether your approach worked?
- How did you decide what the problem was asking you to find? (What was unknown?)
- Did you try a method that did not work? Why didn’t it work? Would it ever work? Why or why not?
- What is the same and what is different about...?
- How could you demonstrate a counter-example?
- I think it might be clearer if you said … Is that what you meant
- Is your method like Shawna’s method or how is it different?

MP 4 Model with mathematics.
- Understand this is a way to reason quantitatively and abstractly (able to decontextualize and contextualize).
- Apply the mathematics they know to solve everyday problems.
- Simplify a complex problem and identify important quantities to look at relationships.
- Represent mathematics to describe a situation either with an equation or a diagram and interpret the results of a mathematical situation.
- Reflect on whether the results make sense, possibly improving/revising the model.
- Ask themselves, “How can I represent this mathematically?”
- What math drawing or diagram could you make and label to represent the problem?
- What are some ways to represent the quantities?
- What is an equation or expression that matches the diagram, number line, chart, table..?
- Where did you see one of the quantities in the task in your equation or expression?
- How would it help to create a diagram, graph, table...?
- What are some ways to visually represent...?
- What formula might apply in this situation?

MP 5 Use appropriate tools strategically.
- Use available tools including visual models, recognizing the strengths and limitations of each.
• Use estimation and other mathematical knowledge to detect possible errors.
• Identify relevant external mathematical resources to pose and solve problems.
• Use technological tools to deepen their understanding of mathematics.
• What mathematical tools could we use to visualize and represent the situation?
• What information do you have?
• What do you know that is not stated in the problem?
• What approach are you considering trying first?
• What estimate did you make for the solution?
• In this situation would it be helpful to use a graph, number line, ruler, diagram, calculator, manipulative…?
• Why was it helpful to use...
• What can using a _____ show us that _____ may not?
• In what situations might it be more informative or helpful to use...

MP 6 Attend to precision.
• Communicate precisely with others and try to use clear mathematical language when discussing their reasoning.
• Understand the meanings of symbols used in
• What mathematical terms apply in this situation?
• How did you know your solution was reasonable?
• Explain how you might show that your solution answers the problem.
• What would be a more efficient strategy?

MP 7 Look for and make use of structure.
• Look for the overall structures and patterns in mathematics. Think about how to describe these in words, math symbols, or visual models.
• See complicated things as single objects or as being composed of several objects. Compose and decompose conceptually.
• Apply general mathematical patterns, rules, or procedures to specific situations.
• What observations can you make about...
• What do you notice when...
• What parts of the problem might you eliminate, simplify...
• What patterns do you find in...
• How do you know if something is a pattern?
• What ideas that we have learned before were useful in solving this problem?
• What are some other problems that are similar to this one?
• How does this relate to...?
• In what ways does this problem connect to other mathematical concepts?

MP 8 Look for and express regularity in repeated reasoning.
• See repeated calculations and look for generalizations and shortcuts.
• See the overall process of the problem and still attend to the details in the problem solving steps.
• Understand the broader application of patterns and see the structure in similar situations.
• Continually evaluate the reasonableness of their intermediate results
• Explain how this strategy works in other situations.
• Is this always true, sometimes true or never true?
• How would we prove that...?
• What do you notice about...?
• What is happening in this situation?
• What would happen if...?
• Is there a mathematical rule for...?
• What predictions or generalizations can this pattern support?
• What mathematical consistencies do you notice?
• How is this situation like and different from other situations using this operation?

Assessments Including Methods and/or Tools

Students will experience a variety of assessments in each unit. Daily assignments will be used as a way to assess a student on an ongoing basis. These are used to gain immediate feedback on whether students understand the content of the unit. Shorts quizzes will be used throughout each unit to assess longer term knowledge. Unit tests will be given to assess how well students can integrate all knowledge learned in each unit. These tests will contain longer constructed response questions so as to assess the students’ math knowledge and communication skills. These some parts of the assessments will be available to be taken with the use of technology. Other assessment tools will be in the form of group and individual presentations. These can be used to gauge how well the student can communicate their understanding and how they arrive at their conclusions (MP 2, MP 3, MP 4, MP 5, MP 6, MP 7). Students may also be asked to keep an ongoing portfolio that shows examples of how they use the eight mathematical practices throughout each unit. Performance tasks will be given throughout the year and specifically during the modeling units so that the students can demonstrate the ability to use information from various units to solve longer more in depth problems (MP 1, MP 2, MP 3, MP 4, MP 5, MP 6) There will be a cumulative final at the end of each semester.

Open Response, Group, and Writing Tasks: Students are asked to analyze, problem solve, experiment, make decisions, measure, cooperate with others, present orally, or produce a product.
Modeling Units: The tasks assigned during the modeling units serve to connect all of the mathematics learned during the previous units into a cohesive whole. Also, these projects are usually grounded in real world situations, and stress applications of the mathematics learned. The students practice using mathematics that

Observational assessment: Teacher observes their students in the classroom setting, monitoring for certain skills or behaviors, and jotting them down when they are evidenced. In this way teachers are able to assess not only their students’ academic growth, but also their emotional growth. Typically a teacher might be looking for mastery of some topic, but just as important are the affective traits such as demonstrating a valuing of mathematics, or a positive attitude in the face of difficulty.

Traditional Assessments: regular end of unit exams and quizzes (multiple choices, short answer, and written extended response problems). These assessments will include problems that require students to use the mathematical knowledge and skills gained within a unit to solve problems that are unfamiliar and do not exactly match those of problems seen before. Results are reviewed and analyzed by teachers and administrators to develop a learning plan for students who have not mastered material.