

Newport Mesa Unified School District
Course Description

HNR PRE-CALCULUS
1 Year Course (1AB)

Content covered in this course is described in the Course of Study. Based upon student needs, teachers select appropriate materials from the Instructional Materials List. Classroom presentations of course content are determined by the instructor and described under Teacher Activities. The instructor can provide a more detailed outline of this course.

PREREQUISITES:

The Honors Pre-Calculus course has prerequisites and the individual sites will determine this. Any or parts of the following will be required: teacher recommendation, completion of summer assignments, and grade requirement in previous classes taken at the respective school.

OVERVIEW:

This one-year course is an accelerated program designed to both challenge the honors student by providing the greater depth commonly found in collegiate level courses and to prepare the student for calculus and other higher mathematics courses. Emphasis is placed on complex and thought provoking assignments designed to further develop and enhance the capacity for advanced mathematical thought. Students electing to take this class must have proficiency in algebra 2AB as judged by both the preceding and current instructors. Students who master this course will gain experience with the analysis of elementary functions and their graphs, graphing techniques, functions and their inverses, trigonometric functions, trigonometric identities, right and oblique triangles, the polar coordinate system, complex numbers in trigonometric form, logarithmic and exponential functions, vectors, the principle of mathematical induction, analytic geometry, systems of equations and inequalities, matrices, determinates, sequences, series, and a preview of calculus including the limit, derivative, and integral. Critical to the success of the students will be their ability to think, reason, and communicate mathematically. A comprehensive written final exam will be administered at the completion of this course.

COURSE OF STUDY OBJECTIVES:

1.0 The student will analyze and graph elementary functions and their inverses.

1.1 SUGGESTED STUDENT ACTIVITIES:

- Determine whether a relation represents a function and identify the graph of a function
- Find the domain of a function and form the sum, product, difference, quotient, and composition of functions and find their domain
- Graph constant, linear, square, cube, square root, reciprocal, absolute value, and piecewise defined functions
- Find the average rate of change, local extrema, and where a function is increasing, decreasing, or constant
- Determine whether a function is even or odd, continuous, one-to-one, and test for symmetry when given either an equation or a graph
- Graph functions using reflections about the x-axis or y-axis, compressions, stretches, and vertical or horizontal shifts
- Construct an appropriate function of best fit to data
- Identify the horizontal, vertical, and oblique asymptotes and points of discontinuity of rational functions and graph rational functions
- Find the inverse function f^{-1} and obtain the graph or domain and range of the inverse function from the graph or domain and range from the function and demonstrate that f and f^{-1} are symmetric with respect to the line $y = x$
- Use synthetic division to locate the real zeros and determine the bounds on zeros of a polynomial function

- Use Descartes rule of signs to determine the number of positive and negative real roots of a polynomial
- Use the Factor, Remainder, Rational Roots, and Conjugate Roots Theorems to find all zeros of a polynomial and apply those values and their multiplicities to graph and factor a polynomial function
- Effectively use graphing calculator technology to find zeros, extrema, and intersections of equations to graph and solve equations

1.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

1.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators
- Assign written and research investigations

2.0 The student will solve problems relating sequences and series including the principle of mathematical induction.

2.1 SUGGESTED STUDENT ACTIVITIES:

- Use recursive as well as sum and term formulas to analyze arithmetic and geometric sequences
- Use the Binomial Theorem or the Pascal Triangle to generate specific terms in the expansion of $(a + b)^n$
- Find the limit of the nth term of some rational sequences
- Use calculators to find terms for sequences and explore possible limits for sequences using large values of n
- Prove formulas using the technique of mathematical induction
- Find the limit of a sequence and the limit of a function as the independent variable approach a number or infinity
- Determine if certain sequences converge or diverge
- Use sigma notation for a series
- Find the sum of finite and infinite arithmetic and geometric series

2.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

2.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators
- Assign written and research investigations

3.0 The student will solve polynomials over the field of complex numbers including techniques for finding roots as well as information about roots.

3.1 SUGGESTED STUDENT ACTIVITIES:

- Apply Descartes Rule of Signs
- Explain the relationship between the graph of a polynomial function and the multiplicity of zeros
- Use a graphing calculator to graph polynomial functions and estimate zeros and extrema
- Simplify expressions involving complex numbers
- Use the trigonometric form of complex numbers and understand that a function of a complex variable can be viewed as a function of two real variables
- Identify a proof of De Moivre's Theorem

- Explain and apply the statement of the Fundamental Theorem of Algebra
- 3.2 INSTRUCTIONAL MATERIALS USED:
 - Adopted textbook
 - Graphing calculators
 - Calculator Based Ranger and Calculator Based Laboratory
- 3.3 TEACHER ACTIVITIES:
 - Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators
 - Assign written and research investigations

4.0 The student will use exponential and logarithmic functions to solve equations and applied problems.

- 4.1 SUGGESTED STUDENT ACTIVITIES:
 - Simplify logarithmic and exponential equations
 - Solve logarithmic and exponential equations
 - Apply exponential functions to growth and decay problems
 - Find the domain and range and graph exponential functions
 - Find the domain and range graph logarithmic functions of any appropriate base
 - Discuss the relationship exponential and logarithmic functions
 - Use a graphing calculator to solve exponential and logarithmic problems and fitting an exponential or logarithmic function to data
- 4.2 INSTRUCTIONAL MATERIALS USED:
 - Adopted textbook
 - Graphing calculators
 - Calculator Based Ranger and Calculator Based Laboratory
- 4.3 TEACHER ACTIVITIES:
 - Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
 - Assign written and research investigations

5.0 The student will be introduced to finding limits of functions, determining where functions are continuous, finding the derivative of function, and finding the integral of functions.

- 5.1 SUGGESTED STUDENT ACTIVITIES:
 - Find the limit of a function using a table or a graph
 - Find the limit of a sum, difference, product, and a quotient, a polynomial, a power or a root, and an average rate of change
 - Find the one-sided limits of a function
 - Determine whether a function is continuous
 - Find an equation of a tangent line to the graph of a function
 - Find the derivative of a function and its instantaneous rate of change
 - Solve derivative problems with physics applications
 - Approximate the area under the graph of a function and approximate integrals with a graphing calculator
- 5.2 INSTRUCTIONAL MATERIALS USED:
 - Adopted textbook
 - Graphing calculators
- 5.3 TEACHER ACTIVITIES:
 - Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
 - Assign written and research investigations

6.0 The student will graph the conic sections.**6.1 SUGGESTED STUDENT ACTIVITIES:**

- Graph conic sections in the Cartesian coordinate system
- Use a graphing calculator to graph conic sections
- Demonstrate and explain the effect of changing the values of a , h , and k to the graph of the quadratic function $y = a(x - h)^2 + k$
- Given a quadratic equation of the form $ax^2 + by^2 + cx + dy + e = 0$, complete the square and put the equation into standard form and recognize whether the graph of the equation is a circle, ellipse, hyperbola, or parabola, and graph the equation

6.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators

6.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

7.0 The student will define the six trigonometric functions in terms of the unit circle as well as the sides of a right triangle.**7.1 SUGGESTED STUDENT ACTIVITIES:**

- Measure sides of similar right triangles and write ratios
- Construct unit circles and label sine and cosine values for quadrantal and other common angles
- Determine the value of the six trigonometric ratios for quadrantal and other common angles
- Solve right triangles for missing sides and angles
- Measure inaccessible distances using right triangles
- Write angles in both degree and radian measure
- Convert between radians and degrees
- Apply the trigonometric functions based on the coordinate system
- Find the linear and angular velocity of a point moving at a constant speed along a circle
- Find the arc length of an arc and the area of a sector of a circle

7.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

7.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

8.0 The student will graph each of the six trigonometric functions with variations.**8.1 SUGGESTED STUDENT ACTIVITIES:**

- Graph trigonometric functions on the Cartesian coordinate system
- Use a graphing calculator to graph trigonometric functions
- Discuss variations of graphs of trigonometric functions for analytical geometry point of view
- Interpret A , ω , ϕ , and B in terms of amplitude, period, phase shift, and vertical shift, domain, and range of sinusoidal functions such as $f(x) = A \sin[\omega(x - \phi)] + B$
- Define the relationship of the tangent function and the slope of a line
- Define the inverse trigonometric functions and graph the inverse trigonometric functions
- Graph sums and differences of functions by the method of "addition of ordinates"

8.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

8.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

9.0 **The student will know the ten basic trigonometric identities and apply these to verify further identities, solve equations, and simplify expressions.**

9.1 SUGGESTED STUDENT ACTIVITIES:

- Derive $\sin^2 \theta + \cos^2 \theta = 1$ and $\tan^2 \theta + 1 = \sec^2 \theta$ and $\cot^2 \theta + 1 = \csc^2 \theta$
- Use identities to compute exact values of the trigonometric functions at various standard points
- Use the ten basic identities and definitions to prove and/or simplify other trigonometric identities

9.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

9.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

10.0 **The student will solve trigonometric equations including general and specific solutions.**

10.1 SUGGESTED STUDENT ACTIVITIES:

- Solve trigonometric equations involving the trigonometric functions
- Solve trigonometric equations in quadratic form
- Solve trigonometric equations graphically

10.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

10.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

11.0 **The student will solve right and oblique triangles.**

11.1 SUGGESTED STUDENT ACTIVITIES:

- Use trigonometry to determine unknown sides or angles in right triangles
- Determine the area of a triangle given one angle and two adjacent sides
- Apply the Law of Sines and the Law of Cosines to routine and non-routine problems
- State the number of triangles that would be possible given different side lengths and angle sizes, including the ambiguous case of Side-Side-Angle

11.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

11.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create

- assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

12.0 The student will apply polars to the plane as well as to the algebra of complex numbers.

12.1 SUGGESTED STUDENT ACTIVITIES:

- Graph points and simple polar equations on the polar plane
- Use graphing calculators to graph polar equations on the polar plane
- Discuss variations of graphs of polar equations from an analytical geometry point of view
- Determine polar coordinates of a point given in rectangular coordinates and vice versa
- Represent equations given in rectangular coordinates in terms of polar coordinates
- Represent a complex number in polar form and know how to multiply numbers in their polar form
- Utilize De Moivre's Theorem and can give the n th roots of a complex number given in polar form
- Identify some of the graphs as lemniscates, cardioids, roses, and spirals

12.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

12.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

13.0 The student will graph and perform the basic operations on vectors in the plane as well as apply vectors to solve navigation and work problems.

13.1 SUGGESTED STUDENT ACTIVITIES:

- Draw and solve vector problems on graph paper as well as with algebra
- Graph vectors in three dimensional space
- Apply vectors to solve word problems
- Determine the horizontal and vertical components of a vector
- Find the sum and difference of two vectors algebraically and geometrically

13.2 INSTRUCTIONAL MATERIALS USED:

- Adopted textbook
- Graphing calculators
- Calculator Based Ranger and Calculator Based Laboratory

13.3 TEACHER ACTIVITIES:

- Conduct demonstrations and labs, lecture, direct student activities, ask questions, create assessments, and model the appropriate use of graphing calculators.
- Assign written and research investigations

14.0 The student will review skills and concepts that were covered in Algebra 1AB, Geometry 1AB, and Algebra 2AB.

14.1 SUGGESTED STUDENT ACTIVITIES:

- Evaluate algebraic expressions, determine the domain of a variable, graph inequalities, find the distance on the real number line, use the laws of exponents, and evaluate square roots
- Use the Pythagorean Theorem and its converse and know the formulas for surface area and volume of basic geometric shapes
- Add, subtract, multiply, and completely factor polynomials
- Add, subtract, multiply, divide, and reduce rational expressions
- Simplify mixed quotients
- Solve equations in one variable, solve equations using the square root method, and solve quadratic equations by completing the square or by using the quadratic formula

- Add, subtract, multiply, and divide complex numbers
- Work with n th roots, simplify radicals, rationalize denominators, and simplify expressions with rational exponents

INSTRUCTIONAL MATERIALS:

TEXTBOOK: Precalculus Enhanced with Graphing Utilities
3rd edition, by Sullivan and Sullivan III

This textbook was approved for use in 2003 for the Honors Trigonometry and Honors Precalculus classes.

This course combines content standards from trigonometry, mathematical analysis, linear algebra, algebra II, and calculus adopted by the California Department of Education.

Course submitted by Brandon Clay, Newport Harbor High School, March 2004

Name of this Course changed from Honors Pre-Calculus to HNR Pre-Calculus per Barry Barowitz on 5/11/2004.