URBANDALE COMMUNITY SCHOOL DISTRICT
CURRICULUM FRAMEWORK OUTLINE

SUBJECT: **Mathematics**
COURSE TITLE: **Pre-Calculus** **2 Credits/2 Semesters**
PREREQUISITES: **Trigonometry Credit, Algebra II Credits**
(*Trigonometry must be completed before or taken concurrently with first semester Pre-calculus.*)

COURSE DESCRIPTION:
Pre-Calculus is designed to prepare students for a course in calculus at the college level. This course is for students who intend to continue their education in mathematics, engineering, science, or other math-related areas, or who are interested in learning mathematics as a part of their total education. A secondary purpose is to provide students not planning a math-related career with the mathematics they need to pass-out of required math courses at the college level. *Pre-calculus corresponds to MAT 129 in the DMACC course guide. To qualify for the 5 hours of DMACC credit, a student must be a junior or senior, must complete the full year class (fall and spring semesters) and register in the second semester with DMACC. Sophomores attending will need administrative approval for DMACC credit.*

STANDARDS AND COURSE BENCHMARKS WITH INDICATORS:
In order that our students may achieve the maximum benefit from their talents and abilities, the students of Urbandale Community School District's Pre-Calculus course should be able to…

Content Standard I: Understand the real and complex number systems.

Benchmark: Use complex numbers in polynomial identities and equations. Iowa Core: HSN.CN.4, 5, 6, 8

Indicators:
- Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers)
- Explain why the rectangular and polar forms of a given complex number represent the same number.
- Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane.
- Use properties of the representation of addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane for computation.
- Calculate the distance between numbers in the complex plane as the modulus of the difference.
- Extend polynomial identities to the complex numbers. For example, rewrite x^2 + 4 as (x + 2i)(x – 2i).

Benchmark: Write expressions in equivalent forms to solve problems. Iowa Core: HSA.SSE.4

Indicators:
- Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems.

Benchmark: Perform arithmetic operations on polynomials. Iowa Core: HSA.APR.2

Indicators: Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

Benchmark: Understand the relationship between zeros and factors of polynomials. Iowa Core: HSA.APR. 3

Indicators: Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Benchmark: Use polynomial identities to solve problems. Iowa Core: HSA.APR.5

Indicators: Know and apply the Binomial Theorem for the expansion of (x + y)^n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

Benchmark: Rewrite rational expressions. Iowa Core: HSA.APR.6, 7

Indicators: 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.

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.

Standard V: Demonstrate reasoning with equations and inequalities.

Benchmark: Solve equations and inequalities in one variable. Iowa Core: HSA.REI.4b

Indicators: Solve quadratic equations by inspection (e.g., for x^2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation.

Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

Benchmark: Solve systems of equations. Iowa Core: HSA.REI.7, 8, 9

Indicators: Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.

Represent a system of linear equations as a single matrix equation in a vector variable.

Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

Benchmark: Represent and solve equations and inequalities graphically. Iowa Core: HSA.REI.11

Indicators: Explain why the x-coordinates of the points where the graphs of the equations y = *f(x)* and y = *g(x)* intersect are the solutions of the equation *f(x) = g(x);* find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or fins successive approximations.

Include cases where *f(x)* and/or *g(x)* are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Standard VI: Understand functions.

Benchmark: Understand the concept of a function and use function notation. Iowa Core: HSF.IF.3

Indicators: Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.

Benchmark: Interpret functions that arise in applications in terms of a context. Iowa Core: HSF.IF.4, 5, 6

Indicators: 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.

Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) 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.

Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Benchmark: Analyze functions using different representations. Iowa Core: HSF.IF.7, 8, 9

Indicators: Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay.

Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Benchmark: Build a function that models a relationship between two quantities. Iowa Core: HSF.BF.1, 2

Indicators: Determine an explicit expression from a context.

Determine a recursive process from a context.

Determine steps for calculation from a context.

Compose functions.
Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

Benchmark: Build new functions from existing functions. Iowa Core: HSF.BF.3, 4, 5

Indicators:
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; include recognizing even and odd functions from their graphs and algebraic expressions for them.
Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x^3 or f(x) = (x+1)/(x–1) for x ≠ 1.
Verify by composition that one function is the inverse of another.
Read values of an inverse function from a graph or a table, given that the function has an inverse.
Produce an invertible function from a non-invertible function by restricting the domain.
Demonstrate an understanding of the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Benchmark: Construct and compare linear, quadratic, and exponential models and solve problems. Iowa Core: HSF.LE.1, 3, 4

Indicators:
Prove that exponential functions grow by equal factors over equal intervals.
Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
For exponential models, express as a logarithm the solution to ab^ct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

Standard VII: Understand statistics & probability.

Benchmark: Summarize, represent, and interpret data on two categorical and quantitative variables. Iowa Core: HSS.ID. 6

Indicators:
Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
Informally assess the fit of a function by plotting and analyzing residuals.