**UT Math 1320-1330 Submission for OTM Precalculus – TMM 002**

**Learning Outcomes for Functions:**

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|   | Learning Outcome Description | Describe how the Courses or Programs address each outcome |
| 1.1  | \* Represent functions verbally, numerically, graphically and algebraically, including linear, quadratic, polynomial, rational, root/radical/power, piecewise-defined, exponential, logarithmic, trigonometric and inverse trigonometric functions. | Given a function in algebraic, graphical, or tabular form or in a verbal or geometric description students will present a second representation of the function and use this to answer questions about its properties. |
| 1.2  | \* Determine whether an algebraic relation or given graph represents a function. | Students will apply the vertical line test to determine whether a relation - given algebraically, graphically, or numerically – is a function. |
| 1.3  | \* Perform transformations of functions – translations, reflections and stretching and shrinking. | Students will rewrite algebraic expressions of functions in standard form for geometric transformations, then graph the functions by employing the sequence of transformations from a standard graph. Conversely students will recognize graphs as transformations of standard graphs and write algebraic expressions for them.  |
| 1.4  | \* Perform operations with functions – addition, subtraction, multiplication, division and composition. | Students will learn to treat functions as named objects on which various operations – addition, subtraction, multiplication, division, and composition – may be performed. Students will determine expressions for new functions built from given functions using these operations. |
| 1.5  | \* Analyze the algebraic structure and graph of a function, including those listed in (1.1), to determine intercepts, domain, range, intervals on which the function is increasing, decreasing or constant, the vertex of a quadratic function, asymptotes, whether the function is one-to-one, whether the graph has symmetry (even/odd), etc., and given the graph of a function to determine possible algebraic definitions. | Students will apply algebraic techniques from Intermediate Algebra to write and solve equations to determine intercepts; to manipulate quadratic expressions into standard form; and then to use this information to sketch the graph. Students will determine properties of functions such as domain, range, symmetry, and injectivity both algebraically and directly from the graph. Conversely students will use properties deduced from a given graph to identify its possible algebraic form. |
| 1.6  | \* Find inverses of functions listed in (1.1) and understand the relationship of the graph of a function to that of its inverse. | Students will determine inverses of functions from algebraic, graphical, and tabular representations.  |
| 1.7  | \* Use the Remainder and Factor Theorems for polynomial functions. | Students will determine the roots of polynomials and evaluate polynomials using the remainder and factor theorem, and factor a polynomial from knowledge of its roots. Conversely students will determine the roots of a polynomial and identify these as then x-intercepts on its graph from representation as a product of linear and quadratic factors. |
| 1.8  | \* Use functions, including those listed in (1.1), to model a variety of real-world problem- solving applications. | Students will take a verbal description of a problem, often accompanied by real-world data, and choose an appropriate function to model the situation. Students will solve for the free parameters algebraically from the given information and use the resulting explicit form to answer questions about the real-world situation. |

**Learning Outcomes for Equations/Systems:**

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|   | Learning Outcome Description | Describe how the Courses or Programs address each outcome |
| 2.1  | \* Understand the difference between an algebraic equation of one, two or more variables and a function, and the relationship among the solutions of an equation in one variable, the zeros of the corresponding function, and the coordinates of the x-intercepts of the graph of that function. | Students will learn functions as entities with properties that can be expressed in algebraic, graphical, tabular, or other forms. Students will determine whether an algebraic or graphical description represents a function. Given an algebraic representation of a function students will be able to represent its x-intercepts as solutions of an equation in 1 variable. |
| 2.2  | \* Determine algebraically and graphically whether the graph of an equation exhibits symmetry. | Students will apply algebraic transformations to determine whether the graph of a function exhibits various types of symmetry. Conversely students will identify from the symmetry of a given graph the possible algebraic forms of its defining function. |
| 2.3  | \* Solve a variety of equations, including polynomial, rational, exponential, and logarithmic, trigonometric and inverse trigonometric, including equations arising in application problems. | Students will solve equations using techniques of polynomial factoring; quadratic formula; obtaining common denominators; using laws of logarithms and exponentials to combine terms and simplify; and using substitutions to transform some transcendental equations into polynomial ones. |
| 2.4  | \* Solve a system of linear equations graphically and algebraically by substitution and elimination, and solve application problems that involve systems of linear equations. | Students will solve systems of equations in 2 variables using the method of substitution, and interpret the solutions as points of intersection of the corresponding graphs. For systems of linear equations in 2 or more variables students will also rewrite the equations in standard form and then employ the systematic procedure of elimination. Given a verbal description of a problem involving several 2 or more quantities students will solve the problem by rewriting the problem as a system of equations and then applying the techniques above. |
| 2.5  | \* Identify and express the conics (quadratic equations in two variables) in standard rectangular form, graph the conics, and solve applied problems involving conics. | Students will complete the square to write conics in standard form then use this information to graph the conic, and conversely will identify the form from a graph and write the resulting equation. Students will perform these tasks given problems in algebraic or verbal form. |
| 2.6  | \* Solve polynomial and rational inequalities graphically andalgebraically. | Students will solve equations using techniques of polynomial factoring; quadratic formula; and obtaining common denominators. Students will interpret these solutions either as the intercepts of a graph or else the points of intersection of 2 graphs, as appropriate. Conversely given information about points of intersection of graphs defined algebraically students will interpret this information by writing equations satisfied by the parameters. |

**Learning Outcomes for Sequences/Series:**

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|   | Learning Outcome Description | Describe how the Courses or Programs address each outcome |
| 3.1  | \* Represent sequences verbally, numerically, graphically and algebraically, including both the general term and recursively. | Students will learn the standard angles, in both degrees and radians, arrayed around the unit circle. Students will change the expression of angles between degrees and radians. |
| 3.2  | \* Write series in summation notation, and represent sequences of partial sums verbally, numerically and graphically. | Given drawings of triangles or verbal descriptions of physical situations students will employ the definitions of and relationships between the trigonometric ratios to solve for unknown sides or angles.  |

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| 3.3  | \* Identify and express the general term of arithmetic and geometric sequences, and find the sum of arithmetic and geometric series. | Students will learn the standard angles, in both degrees and radians, arrayed around the unit circle. Students will change the expression of angles between degrees and radians. |

**Learning Outcomes for More Trigonometry:**

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|   | Learning Outcome Description | Describe how the Courses or Programs address each outcome |
| 4.1  | \* Express angles in both degree and radian measure | Students will learn the standard angles, in both degrees and radians, arrayed around the unit circle. Students will change the expression of angles between degrees and radians. |
| 4.2  | \* Define the six trigonometric functions in terms of right triangles and the unit circle. | Students will identify properties of the trigonometric functions and their inverses with corresponding properties in the unit circle and in right triangles. |
| 4.3  | \* Solve right and oblique triangles in degrees and radians for both special and non-special angles, and solve application problems that involve right and oblique triangles. | Given drawings of triangles or verbal descriptions of physical situations students will employ the definitions of and relationships between the trigonometric ratios to solve for unknown sides or angles. |
| 4.4  | \* Verify trigonometric identities by algebraically manipulating trigonometric expressions using fundamental trigonometric identities, including the Pythagorean, sum and difference of angles, double-angle and half-angle identities. | Students will manipulate algebraic expressions of trigonometric functions to determine whether or not they represent identities or equations with discrete solutions. In the latter case they will solve the equations, as indicated above. In the former they will justify their derivation by appealing to known identities. |
| 4.5  | \* Solve a variety of trigonometric and inverse trigonometric equations, including those requiring the use of the fundamental trigonometric identities listed in (4.4), in degrees and radians for both special and non-special angles. Solve application problems that involve such equations. | Students will develop trigonometric identities, including the addition and subtraction formulas and their corollaries, and apply these to the solution of trigonometric equations. Some of these solutions will be expressed as standard angles, in degrees or radians. Others will require evaluation using a calculator. |

**Learning Outcomes for Vectors:**

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|   | Learning Outcome Description | Describe how the Courses or Programs address each outcome |
| 5.1  | \* Represent vectors graphically in both rectangular and polar coordinates and understand the conceptual and notational difference between a vector and a point in the plane. | Students will learn vectors as expressions of physical quantities that have both a magnitude and direction. They will be contrasted with the expression of location, as in the difference between position and displacement.  |
| 5.2  | \* Perform basic vector operations both graphically and algebraically – addition, subtraction and scalar multiplication. | Students will perform vector operations of addition, subtraction, and scalar multiplication, then sketch the results graphically.  |
| 5.3  | \* Solve application problems using vectors. | Students will solve problems concerning physical quantities such as displacement and resultant forces using vector algebra. |