MECHANICAL/MANUFACTURING ENGINEERING TECHNOLOGY TRANSFER ASSURANCE GUIDE (TAG)
September 30, 2016

Ohio Transfer Module:		
Ohio Transfer Module (OTM) Requirements: 36-40 semester hours. Students should select courses within the OTM that complement the selected major and meet any specific general education requirements. Students are encouraged to complete the OTM to ensure maximum transferability and application of credits.		
Required Disciplines	**Minimum Required Hours**	**Recommended Courses**
Area I. English Composition	3 Semester Hours	
Area II. Mathematics	3 Semester Hours	College Algebra (TMM001) and Trigonometry (TMM003) (Prerequisite) or Precalculus (TMM002) (Prerequisite)
Area III. Arts & Humanities	6 Semester Hours	
Area IV. Social Sciences	6 Semester Hours	
Area V. Natural & Physical Science	6 Semester Hours	General Physics I (Algebra-Based) (OSC014) (Prerequisite). Full sequence may be required by some.
Additional courses beyond the minimum required hours, from any of the disciplines listed above, will count toward the completion of the OTM (36-40 semester hours).		
Advising Note: Students should consult with receiving institution to ensure courses are completed in proper sequence. Students wanting cooperative education programs should consult with target institution as soon as possible.		

Major Courses – Hours/Courses listed below that count toward the major or pre-major requirements	
OET007 – Statics	Credits: 3 Semester Hours
Advising Notes: **Prerequisite**: General Physics I or College Algebra/Trigonometry or Pre-Calculus	
OET008 – Strength of Materials	Credits: 3 Semester Hours
Advising Notes: **Prerequisite**: Statics	
OET009 – Fluid Mechanics	Credits: 3 Semester Hours
Advising Notes: **Prerequisite**: General Physics I or Statics	
OET010 – Manufacturing Processes	Credits: 3 Semester Hours
Advising Notes:	
OET012 – Computer Aided Drafting/Design (CAD)	Credits: 3 Semester Hours
Advising Notes: **Prerequisite:** Engineering Drawing or Engineering Graphics (Prerequisite of Engineering Drawing or Engineering Graphics shall be waived if the course appears to address these concepts within the course.)	
OET013 – Engineering Materials	Credits: 3 Semester Hours
Advising Notes:	

Transfer Assurance Guides Total Guaranteed Credits (Range)	
Ohio Transfer Module (OTM)	36 – 40 Semester Hours
Pre-major/Major	0 – 21 Semester Hours

Institutional Requirements: For entrance and graduation, a transfer student must meet all institutional requirements which would include, but may not be limited to: minimum grade point average, residency requirements, upper division credits attained, minimum grades in specific courses, performance requirements (ex. dance, music) and other requirements of native students from the same institution.

OET007 – Statics
3 Semester Hours
Prerequisites: General Physics I or College Algebra/Trigonometry or Pre-Calculus

Related TAG: Mechanical/Manufacturing Engineering Technology

General Course Description:
Non-calculus based study of forces and force systems on rigid bodies at rest by analytical methods. Topics include forces, moments, equilibrium, centroids and moments of inertia. Applications include beams, trusses, and machine components. Learning outcomes are achieved through various in class and laboratory experiences.

Student Learning Outcomes marked with an asterisk (*) are essential and must be met:

1. Break force vectors into component and combine forces into a resultant.*
2. Determine moments and couples.*
3. Evaluate systems in force and moment static equilibrium.*
4. Determine forces on members in a truss, frame, and pulley.*
5. Apply friction laws to direction, wedges, belt, disk, incline.*
6. Determine the centroid of areas.*
7. Determine moments of inertia.*
8. Analyze forces, unit vectors, components in 3-D.

OET008 – Strength of Materials
3 Semester Hours
Prerequisites: Statics

Related TAG: Mechanical/Manufacturing Engineering Technology

General Course Description:
Analysis of physical properties, strength characteristics, stress development, deformations and failure limits of engineering materials used in different types of loading and support conditions in engineering structures. Mechanical and thermal loads are studied. Applications include axial, bending, and shearing stresses; deflection and rotation; beams, columns, and tension members. Learning outcomes are achieved through various in class and laboratory experiences.

Student Learning Outcomes marked with an asterisk (*) are essential and must be met:

1. Determine the stress, strain and deformation in a member carrying axial tensile or compressive loads.*
2. Determine direct shear stress.*
3. Determine torsional shear stress and deformation.*

4. Determine the stress due to loading in beams.*
5. Analyze the effects of stress concentrations.*
6. Analyze shear stress in beams.*
7. Analyze the deflection of beams due to a variety of loading and support.*

OET009 – Fluid Mechanics
3 Semester Hours
Prerequisites: General Physics I or Statics

Related TAG: Mechanical/Manufacturing Engineering Technology

General Course Description:
This course examines the basic properties of fluids and the topics of pressure, forces, fluids in motion, and viscosity. The application of fluid statics and fluid dynamics to the solution of fundamental engineering fluid problems. The one-dimensional energy and momentum equations are introduced and applied to the solution of fluid flow problems. Learning outcomes are achieved through various in class and laboratory experiences.

Student Learning Outcomes marked with an asterisk (*) are essential and must be met:

1. Explain forces on plane and curved boundaries.*
2. Define piping systems and the dynamics of pipe flow.*
3. Design piping systems involving friction, systems with laminar and turbulent flow.*
4. Explain the difference between absolute and gage pressures.*
5. Explain the principles of hydraulic power transmission.*
6. Apply Pascal's Law and Bernoulli's Equations in the analysis of the properties of fluids.*

OET010 – Manufacturing Processes
3 Semester Hours

Related TAG: Mechanical/Manufacturing Engineering Technology

General Course Description:
The focus of this course is to provide the student with an introduction to common major manufacturing processes. Students will study and gain practical experience in various manufacturing processes such as metrology, materials, heat-treating, machine operations, metal forming, extrusions, castings, welding, finishing, adhesion, fasteners, assembly, and applications of empirical data to determine speeds and feeds to optimize production efficiencies. Learning outcomes are achieved through various in class and laboratory experiences.

Student Learning Outcomes marked with an asterisk (*) are essential and must be met:

1. Demonstrate an understanding of the interrelationships between material properties and manufacturing processes. *
2. Distinguish between different manufacturing processes such as forgings, extrusions, castings, forming, and finishing.*
3. Distinguish between different fabrication processes such as welding, fasteners, and adhesives.*
4. Apply process parameters to optimize production efficiencies.*
5. Demonstrate appropriate safety procedures and methods in a manufacturing setting.*
6. Demonstrate proficiency in the use of measurement instruments.*

OET012 – Computer Aided Drafting/Design (CAD)
3 Semester Hours
Prerequisite: Engineering Drawing or Engineering Graphics
(Prerequisite of Engineering Drawing or Engineering Graphics shall be waived if the course appears to address these concepts within the course.)

Related TAG: Mechanical/Manufacturing Engineering Technology

General Course Description:
This course introduces the student to the fundamental concepts used in creating computer-generated drawings using a commercial CAD software. Topics include coordinate systems, construction, text insertion, editing techniques, views, projections, display control, inquiry techniques, dimensioning and use of part libraries in the creation of drawings and assemblies. Bill of materials will be generated from multi-sheet assemblies. Students will develop 3D objects using primitive solids and Boolean operations. Learning outcomes are achieved through various in class and laboratory experiences.

Student Learning Outcomes marked with an asterisk (*) are considered and must be met:

1. Demonstrate proficiency of a commercial CAD system based on ASME (ANSI) Y14.5M or equivalent ISO standards.*
2. Create working drawings using orthographic projections, section views, and auxiliary views.*
3. Create detail drawings that include dimensions and tolerances.*
4. Create assembly drawings including bill of materials.*
5. Demonstrate a basic knowledge of 3D modeling*

The original course has been updated to focus on the intent of a CAD course, while allowing the use of either 2D or 3D CAD packages. OET021 3D Modeling has been eliminated.

OET013 – Engineering Materials
3 Semester Hours

Related TAG: Mechanical/Manufacturing Engineering Technology

General Course Description:
This course covers the basic physical and chemical properties of materials, structures, and technical information required to select appropriate materials and treatment processes that could be used in engineering applications. Also covered are the limitations and production processes of material such as plastics, metals, ceramics, composites, cemented carbides, and other materials and variety of testing methods used for selection and specifying design specifications. Learning outcomes are achieved through various in class and laboratory experiences.

Student Learning Outcomes marked with an asterisk (*) are essential and must be met:

1. Describe how engineering materials including metals, polymers, ceramics, and composites are related in origin and structural characteristics such as crystal structure, organic composition and properties, basic chemistry and atomic structure.*
2. Explain the mechanical properties that must be reviewed when making materials selections including hardness, modulus of elasticity, tensile strength, yield strength, and shear strength.*
3. Describe how steels are made including alloying and primary processes such as melting, casting, hot rolling, and cold rolling.
4. Describe how modifying chemical compositions, cold working, and heat treatments alter material properties.*
5. Select the appropriate engineering materials based upon their properties.*

OSC014 – Algebra-based Physics I (w/ labs)
4-5 Semester Hours
Co-requisites: College Algebra and Pre-calculus

Related TAGs: Biology, Chemistry, Civil/Construction Engineering Technology, Electrical Engineering Technology, Mechanical Engineering Technology

Understanding and/application of the following topics using calculus concepts and methods where appropriate:

1. Kinematics – one and two dimensional
2. Vectors – vector Arithmetic
3. Force and Newton's Laws of Motion
4. Work, Energy, Conservation of Energy
5. Linear momentum
6. Collisions
7. Rotational kinematics and dynamics
8. Angular momentum and rotational energy
9. Simple harmonic motion

10. Waves and sound
11. Solid and fluid properties
12. Heat and thermodynamics
13. Kinetic theory of gases

TMM001 – College Algebra (Revised December 8, 2015; updated samples April 30, 2016)
Typical Range: 3-4 Semester Hours
Recommendation: This course should significantly reflect the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics (CUPM) subcommittee, Curriculum Renewal Across the First Two Years (CRAFTY), College Algebra Guidelines.

College Algebra provides students a college level academic experience that emphasizes the use of algebra and functions in problem solving and modeling, where solutions to problems in real-world situations are formulated, validated, and analyzed using mental, paper-and-pencil, algebraic and technology-based techniques as appropriate using a variety of mathematical notation. Students should develop a framework of problem-solving techniques (e.g., read the problem at least twice; define variables; sketch and label a diagram; list what is given; restate the question asked; identify variables and parameters; use analytical, numerical and graphical solution methods as appropriate; determine the plausibility of and interpret solutions).

– Adapted from the MAA/CUPM CRAFTY 2007 College Algebra Guidelines

To qualify for TMM001 (College Algebra), a course must achieve all of the following essential learning outcomes listed in this document (marked with an asterisk). The Sample Tasks are recommendations for types of activities that could be used in the course.

1. Functions: Successful College Algebra students demonstrate a deep understanding of functions whether they are described verbally, numerically, graphically, or algebraically (both explicitly and implicitly). Students should be proficient working with the following families of functions: linear, quadratic, higher-order polynomial, rational, exponential, logarithmic, radical, and piecewise-defined functions (including absolute value).

The successful College Algebra student can:

1a. Analyze functions. Routine analysis includes discussion of domain, range, zeros, general function behavior (increasing, decreasing, extrema, etc.). In addition to performing rote processes, the student can articulate reasons for choosing a particular process, recognize function families and anticipate behavior, and explain the implementation of a process (e.g., why certain real numbers are excluded from the domain of a given function).*
1b. Convert between different representations of a function.*
1c. Perform operations with functions including addition, subtraction, multiplication, division, composition, and inversion; connect properties of constituent functions to properties of the resultant function; and resolve a function into a sum, difference, product, quotient, and/or composite of functions.*

2. Equations and Inequalities: Successful College Algebra students are proficient at solving a wide array of equations and inequalities involving linear, quadratic, higher-order polynomial, rational, exponential, logarithmic, radical, and piecewise-defined functions (including absolute value).

The successful College Algebra student can:

2a. Recognize function families as they appear in equations and inequalities and choose an appropriate solution methodology for a particular equation or inequality and can communicate reasons for that choice.*
2b. Use correct, consistent, and coherent notation throughout the solution process to a given equation or inequality.*
2c. Distinguish between exact and approximate solutions and which solution methodologies result in which kind of solutions.*
2d. Demonstrate an understanding of the correspondence between the solution to an equation, the zero of a function, and the point of intersection of two curves.*
2e. Solve for one variable in terms of another.*
2f. Solve systems of equations using substitution and/or elimination.*

3. Equivalencies: Successful College Algebra students are proficient in creating equivalencies in order to simplify expressions, solve equations and inequalities, or take advantage of a common structure or form.

The successful College Algebra student can:

3a. Purposefully create equivalences and indicate where they are valid.
3b. Recognize opportunities to create equivalencies in order to simplify workflow.*

4. Modeling with Functions: Successful College Algebra students should have experience in using and creating mathematics which model a wide range of phenomena.

The successful College Algebra student can:

4a. Interpret the function correspondence and behavior of a given model in terms of the context of the model.*
4b. Create linear models from data and interpret slope as a rate of change.*
4c. Determine parameters of a model given the form of the model and data.*
4d. Determine a reasonable applied domain for the model as well as articulate the limitations of the model.*

5. Appropriate Use of Technology: Successful College Algebra students are proficient at choosing and applying technology to assist in analyzing functions.

The successful College Algebra student can:

5a. Anticipate the output from a graphing utility and make adjustments, as needed, in order to efficiently use the technology to solve a problem.*
5b. Use technology to verify solutions to equations and inequalities obtained algebraically.*
5c. Use technology to obtain solutions to equations to equations and inequalities which are difficult to obtain algebraically and know the difference between approximate and exact solutions.*

5d. Use technology and algebra in concert to locate and identify exact solutions.*

6. Reasons Mathematically: Successful college algebra students demonstrate a proficiency at reasoning mathematically.

The successful College Algebra student can:

6a. Recognize when a result (theorem) is applicable and use the result to make sound logical conclusions and provide counter-examples to conjectures.*

TMM002 – Pre-Calculus (Updated June 3, 2015)
Typical Range: 5-6 Semester Hours
Recommendation: This course should significantly reflect the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics (CUPM) subcommittee, Curriculum Renewal Across the First Two Years (CRAFTY), College Algebra Guidelines and the CUPM Curriculum Guide.

A Pre-Calculus course is an intensive, more accelerated course for students preparing for a traditional calculus sequence and would generally include essential topics covered in both College Algebra and Trigonometry and as such is only recommended for the more able and prepared student.
Pre-Calculus provides students a college level academic experience that emphasizes the use of algebra and functions in problem solving and modeling, where solutions to problems in real-world situations are formulated, validated, and analyzed using mental, paper-and-pencil, algebraic and technology-based techniques as appropriate using a variety of mathematical notation. Students should develop a framework of problem-solving techniques (e.g., read the problem at least twice; define variables; sketch and label a diagram; list what is given; restate the question asked; identify variables and parameters; use analytical, numerical and graphical solution methods as appropriate; determine the plausibility of and interpret solutions).

– Adapted from the MAA/CUPM CRAFTY 2007 College Algebra Guidelines

Students who are preparing to study calculus need to develop conceptual understanding as well as computational skills. Appropriately designed Pre-Calculus courses can enable students to be successful in calculus. Often, creation of an effective Pre-Calculus course requires learning about different curricular and pedagogical approaches and experimenting with how the most promising ones might be adapted for local implementation. No course should have value *only* as a preparation for a subsequent course; it should have intrinsic value on its own as well as offering preparation for further study.

A Pre-Calculus course should develop mathematical thinking and communications skills by incorporating activities that will help all students progress in developing analytical, critical reasoning, problem-solving, and communication skills and acquiring mathematical habits of mind. More specifically, these activities should be designed to advance and measure students' progress in learning to:

- State problems carefully, modify problems when necessary to make them tractable, articulate assumptions, appreciate the value of precise definition, reason logically to conclusions, and interpret results intelligently;
- Approach problem solving with a willingness to try multiple approaches, persist in the face of difficulties, assess the correctness of solutions, explore examples, pose questions, and devise and test conjectures;
- Read mathematics with understanding and communicate mathematical ideas with clarity and coherence through writing and speaking.

A Pre-Calculus course should communicate the breadth and interconnections of the mathematical sciences by:

- Presenting key ideas and concepts from a variety of perspectives;
- Employing a broad range of examples and applications to illustrate and motivate the material;
- Promoting awareness of connections to other subjects (both in and out of the mathematical sciences), and strengthen each student's ability to apply the course material to these subjects;
- Introducing contemporary topics from the mathematical sciences and their applications and enhancing student perceptions of the vitality and importance of mathematics in the modern world.

– Adapted from the MAA/CUPM 2004 Curriculum Guide

To qualify for TMM002 (Pre-Calculus), a course must cover as a minimum the essential learning outcomes, noted by an asterisk *, which include all the topics under Functions, Equations/Systems, Sequences/Series, More Trigonometry, and Vectors. A course in Pre-Calculus may also commonly include some of the listed nonessential learning outcomes. These optional topics should be included only if there is adequate course time to do so beyond giving primary course attention to the essential learning outcomes. At least 70% of the classroom instructional time has to be spent on the essential learning outcomes. The optional learning outcomes are learning experiences that enhance, reinforce, enrich or are further applications of the essential learning outcomes. If review of prerequisite course content is necessary, only a minimal amount of time should be devoted to such review.

The successful Pre-Calculus student should be able to:

1. Functions *
   - 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.*
   - 1.2 Determine whether an algebraic relation or given graph represents a function.*
   - 1.3 Perform transformations of functions – translations, reflections and stretching and shrinking.*
   - 1.4 Perform operations with functions – addition, subtraction, multiplication, division and composition.*
   - 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.*

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.*
1.7 Use the Remainder and Factor Theorems for polynomial functions.*
1.8 Use functions, including those listed in (1.1), to model a variety of real-world problem-solving applications.*

2. Equations/Systems *
   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.*
   2.2 Determine algebraically and graphically whether the graph of an equation exhibits symmetry.*
   2.3 Solve a variety of equations, including polynomial, rational, exponential, and logarithmic, trigonometric and inverse trigonometric, including equations arising in application problems.*
   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.*
   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.*
   2.6 Solve polynomial and rational inequalities graphically and algebraically.*

3. Sequences/Series *
   3.1 Represent sequences verbally, numerically, graphically and algebraically, including both the general term and recursively.*
   3.2 Write series in summation notation, and represent sequences of partial sums verbally, numerically and graphically.*
   3.3 Identify and express the general term of arithmetic and geometric sequences, and find the sum of arithmetic and geometric series.*

4. More Trigonometry *
   4.1 Express angles in both degree and radian measure.*
   4.2 Define the six trigonometric functions in terms of right triangles and the unit circle.*
   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.*
   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.*
   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.*

5. Vectors *
   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.*
   5.2 Perform basic vector operations both graphically and algebraically – addition, subtraction and scalar multiplication.*

5.3 Solve application problems using vectors.*

6. Perform operations with matrices – addition, subtraction, scalar multiplication and matrix multiplication, including applications with matrices. Use matrices to solve systems of linear equations, including the Gaussian and Gauss-Jordan elimination methods, using a matrix inverse to solve a matrix equation, and Cramer's Rule.

7. Model real-world data with functions for prediction and analysis, including determining the appropriateness of a model and using hand-held calculator or computer regression capability.

8. Use the Rational Zeros Theorem and the Fundamental Theorem of Algebra to find the zeros of and factor a polynomial into linear factors over the complex numbers.

9. Solve a nonlinear system of equations graphically and algebraically, including nonlinear systems of equations arising in application problems.

10. Solve a linear and nonlinear system of inequalities, including linear and nonlinear systems of inequalities arising from application problems.

11. Use the Binomial Theorem.

12. Understand how to eliminate the xy-term in the general quadratic equation in two variables by the rotation of axes, and identify and graph conics with rotated axes.

13. Graph complex numbers in the complex plane in both rectangular and polar form, perform operations on such numbers – addition, subtraction, multiplication and division, and use DeMoivre's Theorem to find the nth roots of a complex number.

14. Convert points and equations between rectangular and polar form, graph polar functions, solve polar equations, identify and express the conics in standard polar form for graphing, and solve applied problems involving conics in polar form.
15. Identify and graph a curve defined by parametric equations by making a table of values and, when possible, eliminating the parameter.

16. Understand the average rate of change of the graph of a function or equation on an interval, and informally understand the instantaneous rate of change of the graph of a function or equation at a point and its connection to the slope of the graph at the point, including application problems.

TMM003 – Trigonometry (Updated June 3, 2015)
Typical Range: 3-4 Semester Hours
Recommendation: This course should significantly reflect the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics (CUPM) Curriculum Guide.

A Trigonometry course may be taken by students preparing to take algebra-based Physics or, together with a suitable College Algebra course, may be taken by students preparing for a traditional calculus sequence. A Trigonometry course is generally not as accelerated as a traditional Pre-Calculus course. Since a Trigonometry course covers many of the same learning outcomes as Pre-Calculus, statements regarding TMM002 Pre-Calculus in the MAA/CUPM 2004 Curriculum Guide also apply to Trigonometry.

Students who are preparing to study calculus need to develop conceptual understanding as well as computational skills. Appropriately designed Trigonometry courses can enable students to be successful in calculus. Often, creation of an effective Trigonometry course requires learning about different curricular and pedagogical approaches and experimenting with how the most promising ones might be adapted for local implementation. No course should have value *only* as a preparation for a subsequent course; it should have intrinsic value on its own as well as offering preparation for further study.

A Trigonometry course should develop mathematical thinking and communications skills by incorporating activities that will help all students progress in developing analytical, critical reasoning, problem-solving, and communication skills and acquiring mathematical habits of mind. More specifically, these activities should be designed to advance and measure students' progress in learning to:

- State problems carefully, modify problems when necessary to make them tractable, articulate assumptions, appreciate the value of precise definition, reason logically to conclusions, and interpret results intelligently;
- Approach problem solving with a willingness to try multiple approaches, persist in the face of difficulties, assess the correctness of solutions, explore examples, pose questions, and devise and test conjectures;
- Read mathematics with understanding and communicate mathematical ideas with clarity and coherence through writing and speaking.

A Trigonometry course should communicate the breadth and interconnections of the mathematical sciences by:

- Presenting key ideas and concepts from a variety of perspectives;
- Employing a broad range of examples and applications to illustrate and motivate the material;
- Promoting awareness of connections to other subjects (both in and out of the mathematical sciences), and strengthen each student's ability to apply the course material to these subjects;
- Introducing contemporary topics from the mathematical sciences and their applications and enhancing student perceptions of the vitality and importance of mathematics in the modern world.

– Adapted from the MAA/CUPM 2004 Curriculum Guide

To qualify for TMM003 (Trigonometry), a course must cover as a minimum the essential learning outcomes, noted by an asterisk *, which include all the topics under Functions, Equations, Angles/Triangles, Identities, and Vectors. A course in Trigonometry may also commonly include some of the listed nonessential learning outcomes. These optional topics should be included only if there is adequate course time to do so beyond giving primary course attention to the essential learning outcomes. At least 70% of the classroom instructional time has to be spent on the essential learning outcomes. The optional learning outcomes are learning experiences that enhance, reinforce, enrich or are further applications of the essential learning outcomes. If review of prerequisite course content is necessary, only a minimal amount of time should be devoted to such review.

The successful Trigonometry student should be able to:

1. Functions *
   1.1 Represent trigonometric and inverse trigonometric functions verbally, numerically, graphically and algebraically; define the six trigonometric functions in terms of right triangles and the unit circle.
   1.2 Perform transformations of trigonometric and inverse trigonometric functions – translations, reflections and stretching and shrinking (amplitude, period and phase shift).
   1.3 Analyze the algebraic structure and graph of trigonometric and inverse trigonometric functions to determine intercepts, domain, range, intervals on which the function is increasing, decreasing or constant, 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.
   1.4 Use trigonometric and inverse trigonometric functions to model a variety of real-world problem-solving applications.

2. Equations *
   2.1 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.

3. Angles/Triangles *
   3.1 Express angles in both degree and radian measure.
   3.2 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.

4. Identities *
   4.1 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.

5. Vectors *
   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.
   5.2 Perform basic vector operations both graphically and algebraically – addition, subtraction and scalar multiplication.
   5.3 Solve application problems using vectors.

6. Graph complex numbers in the complex plane in both rectangular and polar form, perform operations on such numbers – addition, subtraction, multiplication and division, and use DeMoivre's Theorem to find the nth roots of a complex number.

7. Convert points and equations between rectangular and polar form, graph polar functions, solve polar equations, identify and express the conics in standard polar form for graphing, and solve applied problems involving conics in polar form.

8. Identify and graph a curve defined by parametric equations by making a table of values and, when possible, eliminating the parameter.

MECHANICAL/MANUFACTURING ENGINEERING TECHNOLOGY TAG
FACULTY PARTICIPANTS
August-September 2016

Name	Institution
Dan Burklo (Lead)	Northwest State Community College
Sudershan Jetley	Bowling Green State University
Shane Bendele	Columbus State Community College
Thomas Looker	Edison State Community College
Rob Speckert	Miami University
Scott Dilling	The University of Akron
Janet Dong	University of Cincinnati
Randy Wharton	Zane State College

MECHANICAL ENGINEERING TECHNOLOGY TAG
FACULTY PARTICIPANTS

Name	Institution
Shane Bendele	Columbus State Community College
Dan Burklo	Northwest State Community College
Casey Guthridge	Stark State Community College
Kent Hall	Washington State Community College
Thomas Looker	Edison Community College
Thomas Lukach	Lakeland Community College
Bill Lutz	Terra Community College