Ohio Transfer Module Guidelines and Learning Outcomes

Updated – July 21, 2015
Arts and Humanities
(Updated October 2008)

Learning Outcomes:
The course directly emphasizes at least one of the learning outcomes for the Transfer Module. Which of these learning outcomes are addressed and how?

a. Communicate effectively: All general education programs include a component for writing; many also include a component for oral communication or presentation
b. Evaluate arguments in a logical fashion: Competence in analysis and logical argument are explicit learning goals for most general education programs, although these skills go by a variety of names (e.g., critical thinking, analysis, logical thinking, etc.)
c. Employ the methods of inquiry characteristic of natural sciences, social sciences, and the arts and humanities: The tools for solving problems vary across disciplines; general education introduces students to methods of inquiry in several fields of study and thereby prepares students to integrate information from different disciplines
d. Acquire an understanding of our global and diverse culture and society
e. Engage in our democratic society: One of the overarching goals of general education is to prepare students to be active and informed citizens, the development of a disposition to participate in and contribute to our democracy is full of equal importance to the goal of having the skills to do so intelligently.

Guideline 1: The course has the required entry level college proficiencies appropriate to the course. Entry level college proficiencies can be shown using a variety of means including placement exams, prerequisite coursework and a description of the course materials.

Guideline 2: Course is not remedial or developmental.

Guideline 3: Course does not cover variable content from term to term.

Guideline 4: Course is not a special topics course.

Guideline 5: Course is not an upper division course.

Guideline 6: Course is not a narrowly-focused technical or pre-technical course.

Guideline 7: Course is an introductory-level course that focuses on the study of human endeavors spanning historical periods, regions and cultures.

Guideline 8: Course is from one of the following disciplines: history of dance, art, music, theatre, film, literature, religion, philosophy, ethics or history.

Guideline 9: Course employs the methods of inquiry characteristic of arts and humanities.

Guideline 10: Course is not a skill developmental or a preparatory course for advanced study in a major (e.g. applied music lessons, studio art, symbolic logic, theatre skills and creative writing).
English Composition
(Created Fall 2009, Incorporated June 2015)

TME001 – English Composition First Writing Course
3 Semester Hours/4-5 Quarter Hours

Learning Outcomes
Outcomes marked with an asterisk are essential and must be taught.

1. Rhetorical Knowledge*
   By the end of their first writing course, students should be able to recognize the elements that inform rhetorical situations. This understanding should enable them to produce expository texts that
   - Have a clear purpose
   - Respond to the needs of intended audiences
   - Assume an appropriate stance
   - Adopt an appropriate voice, tone, style, and level of formality
   - Use appropriate conventions of format and structure

2. Critical Thinking, Reading, and Writing*
   By the end of their first writing course, students should be able to
   - Use reading and writing for inquiry, learning, thinking, and communicating
   - Analyze relationships among writer, text, and audience in various kinds of texts
   - Use various critical thinking strategies to analyze texts

3. Knowledge of Composing Processes*
   By the end of their first writing course, students should be able to
   - Understand writing as a series of steps that includes generating ideas and text, drafting, revising, and editing
   - Recognize that writing is a flexible, recursive process
   - Apply this understanding and recognition to produce successive drafts of increasing quality

4. Collaboration*
   By the end of their first writing course, students should understand that the writing process is often collaborative and social. To demonstrate that understanding, students should be able to
   - Work with others to improve their own and others’ texts
   - Balance the advantages of relying on others with taking responsibility for their own work
5. Knowledge of Conventions*

By the end of their first writing course, students should be able to

- Employ appropriate conventions for structure, paragraphing, mechanics, and format
- Acknowledge the work of others when appropriate
- Use a standard documentation format as needed
- Control syntax, grammar, punctuation, and spelling

6. Composing in Electronic Environments*

Developments in digital technology are expanding our understanding of “writing.” To the extent that technology is available and appropriate, by the end of their first writing course students should be able to

- Understand the possibilities of electronic media/technologies for composing and publishing texts
- Use electronic environments to support writing tasks such as drafting, reviewing, revising, editing, and sharing texts

7. Minimal Course Requirements*

By the end of their first writing course, students will have written

- A variety of texts with opportunities for response and revision
- A minimum of 5000 total words (roughly 20 total pages of written work). Electronic or other projects of equivalent rigor and substance may be included, but the primary focus of the course must be the composing of formal written work

TME002 – English Composition Second Writing Course
3 Semester Hours/4-5 Quarter Hours

The second course in composition may take several forms. For example, it might be a continuation of the first course (such as the second of two first-year composition courses), an intermediate course in written exposition, or a writing-intensive course that is aligned with a specific discipline. However it is conceived, the course should build on the foundations of the first course, developing and expanding concepts and practices that were introduced in the first writing course. It must be a course that focuses on instruction in writing and must meet the following outcomes.

Learning Outcomes

Outcomes marked with an asterisk are essential and must be taught.

1. Rhetorical Knowledge*
Throughout the second writing course, students should build upon the foundational outcomes from the first course:

By the end of their first writing course, students should be able to recognize the elements that inform rhetorical situations. This understanding should enable them to produce expository texts that

- Have a clear purpose
- Respond to the needs of intended audiences
- Assume an appropriate stance
- Adopt an appropriate voice, tone, style, and level of formality
- Use appropriate conventions of format and structure

In addition, by the end of the second course, students should be able to

- Analyze argumentative strategies and persuasive appeals
- Employ appropriate argumentative strategies and persuasive appeals in their writing

2. Critical Thinking, Reading, and Writing*

Throughout the second writing course, students should build upon these foundational outcomes from the first course:

- Use reading and writing for inquiry, learning, thinking, and communicating
- Analyze relationships among writer, text, and audience in various kinds of texts
- Use various critical thinking strategies to analyze texts

In addition, by the end of the second course, students should be able to

- Find and evaluate appropriate material from electronic and other sources
- Analyze and critique sources in their writing
- Juxtapose and integrate ideas and arguments from sources
- Develop a clear line of argument that incorporates ideas and evidence from sources

3. Knowledge of Composing Processes*

Throughout the second writing course, students should build upon these foundational outcomes from the first course:

- Understand writing as a series of steps that includes generating ideas and text, drafting, revising, and editing
- Recognize that writing is a flexible, recursive process
- Apply this understanding and recognition to produce successive drafts of increasing quality

4. Collaboration*

Throughout the second writing course, students should build upon these foundational outcomes from the first course:
• Work with others to improve their own and others’ texts
• Balance the advantages of relying on others with taking responsibility for their own work

5. Knowledge of Conventions*

Throughout the second writing course, students should build upon these foundational outcomes from the first course:

• Employ appropriate conventions for structure, paragraphing, mechanics, and format
• Acknowledge the work of others when appropriate
• Use a standard documentation format as needed
• Control syntax, grammar, punctuation, and spelling

In addition, by the end of the second course, students should be able to

• Employ appropriate textual conventions for incorporating ideas from sources, e.g., introducing and incorporating quotations; quoting, paraphrasing, and summarizing

6. Composing in Electronic Environments*

Throughout the second writing course, students should build upon these foundational outcomes from the first course:

Developments in digital technology are expanding our understanding of “writing.” To the extent that technology is available and appropriate, by the end of their first writing course students should be able to

• Understand the possibilities of electronic media/technologies for composing and publishing texts
• Use electronic environments to support writing tasks such as drafting, reviewing, revising, editing, and sharing texts

In addition, by the end of the second course, students should be able to

• Locate, evaluate, organize, and use research material collected from various sources, including scholarly library databases, other official databases (e.g., federal government databases), and informal electronic networks and internet sources

7. Minimal Course Requirements*

By the end of their second writing course, students will have written

• A variety of texts, including at least one researched essay, with opportunities for response and revision
• A minimum of 5000 total words (roughly 20 total pages of written work). Electronic or other projects of equivalent rigor and substance may be included, but the primary focus of the course must be the composing of formal written work
Mathematics, Statistics, and Logic  
(Revised July 21, 2015)

Learning Outcomes: 
The course directly emphasizes at least one of the learning outcomes for the Transfer Module. Which of these learning outcomes are addressed and how?

a. Communicate effectively: All general education programs include a component for writing; many also include a component for oral communication or presentation.

b. Evaluate arguments in a logical fashion: Competence in analysis and logical argument are explicit learning goals for most general education programs, although these skills go by a variety of names (e.g., critical thinking, analysis, logical thinking, etc.).

c. Employ the methods of inquiry characteristic of natural sciences, social sciences, and the arts and humanities: The tools for solving problems vary across disciplines; general education introduces students to methods of inquiry in several fields of study and thereby prepares students to integrate information from different disciplines.

d. Acquire an understanding of our global and diverse culture and society

e. Engage in our democratic society: One of the overarching goals of general education is to prepare students to be active and informed citizens, the development of a disposition to participate in and contribute to our democracy is full of equal importance to the goal of having the skills to do so intelligently.

Guideline 1: A credit-bearing, college-level course in Mathematics must use the standards required for high school graduation by the State of Ohio as a basis and must do at least one of the following: 1) broaden, or 2) deepen, or 3) extend the student's learning.

Guideline 2: Course does not cover variable learning outcomes from term to term.

Guideline 3: Course is not an upper-division course.

Guideline 4: Course is in the area of mathematics, or statistics, or logic.
Ohio Transfer Module Courses with Learning Outcomes
(Incorporated June 2015)

TMM001 – College Algebra
(Implemented Fall 2009)

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 cover as a minimum the essential learning outcomes, noted by an asterisk *, which include all the topics under Functions and Equations/Systems. A course in College Algebra 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 College Algebra student should be able to:

1. Functions*

   1.1 Represent functions verbally, numerically, graphically and algebraically, including linear, quadratic, polynomial, rational, root/radical/power, exponential, logarithmic and piecewise-defined 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, 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 Solve polynomial and rational inequalities graphically and algebraically.*

3. Identify and express the conics in standard rectangular form, graph the conics, and solve applied problems involving conics.

4. 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.

5. 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.

6. 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.

7. Solve a nonlinear system of equations graphically and algebraically, including nonlinear systems of equations arising in application problems.
8. Solve a linear and nonlinear system of inequalities, including linear and nonlinear systems of inequalities arising from application problems.

9. Express general terms of various sequences (e.g., arithmetic and geometric), write series in summation notation, find the sum of arithmetic and geometric series, and use the Binomial Theorem.

TMM002 – Pre-Calculus
(Implemented Fall 2009)

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).

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;
• Introduce contemporary topics from the mathematical sciences and their applications, and enhance 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 n\textsuperscript{th} 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  
(Implemented Winter 2010)

**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;
- Introduce contemporary topics from the mathematical sciences and their applications, and enhance 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 n<sup>th</sup> 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.

TMM017 – Calculus I & II Sequence (Combination of TMM005 and 006)

Typical Range: 8-10 Semester Hours

TMM005 - Calculus I
(Implemented Winter 2010)

Typical Range: 4-5 Semester Hours

In a Calculus I course, students should:

- develop mathematical thinking and communication skills and learn to apply precise, logical reasoning to problem solving.
- be able to communicate the breadth and interconnections of the mathematical sciences through being presented key ideas and concepts from a variety of perspectives, a broad range of examples and applications, connections to other subjects, and contemporary topics and their applications.
- experience geometric as well as algebraic viewpoints and approximate as well as exact solutions.
- use computer technology to support problem solving and to promote understanding, as most calculus students, especially those who may take only one semester, profit from the use of a graphing utility and a tool for numerical integration.
- for students in the mathematical sciences, progress from a procedural/computational understanding of mathematics to a broad understanding encompassing logical reasoning, generalization, abstraction, and formal proof; gain experience in careful
analysis of data; and become skilled at conveying their mathematical knowledge in a variety of settings, both orally and in writing.

– Adapted from the MAA/CUPM 2004 Curriculum Guide

To qualify for OTM equivalency of TMM005 (Calculus I), a course must cover as a minimum the essential learning outcomes, denoted by an asterisk (*). A Calculus I course 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 Calculus I student should be able to apply the following competencies to a wide range of functions, including piecewise, polynomial, rational, algebraic, trigonometric, inverse trigonometric, exponential and logarithmic:

1. Determine the existence of, estimate numerically and graphically and find algebraically the limits of functions. Recognize and determine infinite limits and limits at infinity and interpret them with respect to asymptotic behavior. *

2. Determine the continuity of functions at a point or on intervals and distinguish between the types of discontinuities at a point. *

3. Determine the derivative of a function using the limit definition and derivative theorems. Interpret the derivative as the slope of a tangent line to a graph, the slope of a graph at a point, and the rate of change of a dependent variable with respect to an independent variable. *

4. Determine the derivative and higher order derivatives of a function explicitly and implicitly and solve related rates problems. *

5. Determine absolute extrema on a closed interval for continuous functions and use the first and second derivatives to analyze and sketch the graph of a function, including determining intervals on which the graph is increasing, decreasing, constant, concave up or concave down and finding any relative extrema or inflection points. Appropriately use these techniques to solve optimization problems. *

6. Determine when the Mean Value Theorem can be applied and use it in proofs of other theorems such as L’Hopital’s rule.

7. Use differentials and linear approximations to analyze applied problems.
8. Determine antiderivatives, indefinite and definite integrals, use definite integrals to find areas of planar regions, use the Fundamental Theorems of Calculus, and integrate by substitution.*

TMM006 – Calculus II
(Implemented Winter 2010)

Typical Range: 4-5 Semester Hours

In a Calculus II course, students should:

- develop mathematical thinking and communication skills and learn to apply precise, logical reasoning to problem solving, as emphasized in the calculus renewal movement.
- be able to communicate the breadth and interconnections of the mathematical sciences through being presented key ideas and concepts from a variety of perspectives, a broad range of examples and applications, connections to other subjects, and contemporary topics and their applications.
- experience geometric as well as algebraic viewpoints and approximate as well as exact solutions.
- use computer technology to support problem solving and to promote understanding (e.g., technology allows students easy access to the graphs of planar curves and visualization helps students understand concepts such as approximation of integrals by Riemann sums or functions by Taylor polynomials; symbolic manipulation can be handled allowing students to focus their attention on understanding concepts; computer algorithms can be explored; and conjectures can be posited, investigated and refined, such as manipulating parameters on classes of functions and fitting functional models to data).
- for students in the mathematical sciences, progress from a procedural/computational understanding of mathematics to a broad understanding encompassing logical reasoning, generalization, abstraction, and formal proof; gain experience in careful analysis of data; and become skilled at conveying their mathematical knowledge in a variety of settings, both orally and in writing.

– Adapted from the MAA/CUPM 2004 Curriculum Guide

To qualify for OTM equivalency of TMM006 (Calculus II), a course must cover as a minimum the essential learning outcomes, denoted by an asterisk (*). A Calculus II course 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 Calculus II student should be able to:

1. Use antiderivatives to evaluate definite integrals and apply definite integrals in a
variety of applications to model physical, biological or economic situations. Whatever applications (e.g. determining area, volume of solids of revolution, arc length, area of surfaces of revolution, centroids, work, and fluid forces) are chosen, the emphasis should be on setting up an approximating Riemann sum and representing its limit as a definite integral.*

2. Approximate a definite integral by the Trapezoidal Rule and Simpson's Rule.

3. Employ a variety of integration techniques to evaluate special types of integrals, including substitution, integration by parts, trigonometric substitution, and partial fraction decomposition.*

4. Evaluate limits that result in indeterminate forms, including the application of L'Hôpital's Rule.*

5. Evaluate improper integrals, including integrals over infinite intervals, as well as integrals in which the integrand becomes infinite on the interval of integration.*

6. Find, graph, and apply the equations of conics, including conics where the principal axes are not parallel to the coordinate axes.

7. Determine the existence of, estimate numerically and graphically, and find algebraically the limits of sequences. Determine whether a series converges by using appropriate tests, including the comparison, ratio, root, integral and alternating series tests.*

8. Find the $n$th Taylor polynomial at a specified center for a function and estimate the error term. Use appropriate techniques to differentiate, integrate and find the radius of convergence for the power series of various functions.*

9. Analyze curves given parametrically and in polar form and find the areas of regions defined by such curves.*

10. Perform and apply vector operations, including the dot and cross product of vectors, in the plane and space.

TMM 010- Introductory Statistics
(Implemented Winter 2010)

Typical Range: 3 - 4 Semester Hours

Non-Calculus Based Statistics Learning Outcomes (for a general education course or a prerequisite course to be followed by a specialized statistics course in a social science discipline.) This description is intended to apply to a range of introductory courses, from highly conceptual (e.g. Statistics: Concepts and Controversies) to more traditional presentations. It is assumed that technology is used (calculators or computer packages) to minimize involved computations.

Outcomes marked with an asterisk are essential and must be taught.

This is a course of study that introduces statistical thinking and statistical methods to those students considering pursuing a business degree. The American Statistical Association has developed a set of six recommendations for the teaching of introductory statistics – these recommendations are known as the “Guidelines for Assessment and Instruction in Statistics Education.” The recommendations are as follows:

1. Emphasize statistical literacy and develop statistical thinking;
2. Use real data;
3. Stress conceptual understanding rather than mere knowledge of procedures;
4. Foster active learning in the classroom;
5. Use technology for developing conceptual understanding and analyzing data; and
6. Use assessments to improve and evaluate student learning.

To qualify for TMM 010 (Introductory Statistics), a course must cover as a minimum the essential learning outcomes, noted by an asterisk *. A course in Introductory Statistics 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.

Real data and hands-on projects should be incorporated throughout the course. The successful non-calculus based statistics student should be able to:
1. Select and produce appropriate graphical, tabular, and numerical summaries of the distributions of variables in a data set. Summarize such information into verbal descriptions.*

2. Summarize relationships in bivariate data using graphical, tabular, and numerical methods including scatter plots, two-way tables, correlation coefficients, and least squares regression lines. Investigate and describe the relationships or associations between two variables using caution in interpreting correlation and association.*

3. Use the normal distribution to interpret z-scores and compute probabilities.*

4. Understand the principles of observational and experimental studies including sampling methods, randomization, replication and control. Understand how the type of data collection can affect the types of conclusions that can be drawn.*

5. Construct a model for a random phenomenon using outcomes, events, and the assignment of probabilities. Use the addition rule for disjoint events and the multiplication rule for independent events. Compute conditional probabilities in the context of two-way tables.*

6. Introduce the concept of a sampling distribution. Discuss the distribution of the sample mean and sample proportion under repeated sampling (Central Limit Theorem). Students should be expected to simulate or generate sampling distributions to observe, empirically, the Central Limit Theorem.*

7. Estimate a population mean or proportion using a point estimate and confidence intervals, and interpret the confidence level and margin of error. Understand the dependence of margin of error on sample size and confidence level.*

8. Determine the appropriate sample size for a specific margin of error and confidence level.

9. Given a research question involving a single population, formulate null and alternative hypotheses. Describe the logic and framework of the inference of hypothesis testing. Make a decision using a p-value and draw an appropriate conclusion. Interpret statistical significance.*

10. Carry out a hypothesis test for a mean or proportion. Interpret statistical and practical significance in this setting.*

11. Perform interval estimation and hypotheses testing for two-sample problems (e.g., difference of two means or proportions and chi-square test of independence).
TMM013 – Business Calculus
(Implemented Winter 2010)

Typical Range: 5-6 Semester Hours

In a Business Calculus course, students should:

- develop mathematical thinking and communication skills and learn to apply precise, logical reasoning to problem solving.
- be able to communicate the breadth and interconnections of the mathematical sciences through being presented key ideas and concepts from a variety of perspectives, a broad range of examples and applications, connections to business and other subjects, and contemporary topics and their applications.
- experience geometric as well as algebraic viewpoints and approximate as well as exact solutions.
- use computer technology to support problem solving and to promote understanding, as most calculus students, especially those who may take only one semester, profit from the use of a graphing utility and a tool for numerical integration.

– Adapted from the MAA/CUPM 2004 Curriculum Guide

To qualify for TMM 013 (Business Calculus), a course must cover as a minimum the essential learning outcomes, noted by an asterisk. A course in Business 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 Business Calculus student should be able to apply the following competencies to a wide range of functions, including piecewise, polynomial, rational, algebraic, exponential and logarithmic:

1. Demonstrate an understanding of limits and continuity.
   
   1.01 Determine limits analytically, numerically and graphically including one-sided limits and limits at infinity.*

   1.02 Analyze the limit behavior of a function at a point in its domain to determine if the function is continuous at that point. Determine intervals in which a function is continuous. Analyze and classify the discontinuities of a function.*

2. Demonstrate an understanding of derivatives and the ability to compute derivatives.

   2.01 Use the limit definition of the derivative to determine the existence and to find the derivative of a given function.*
2.02 Find the derivative of a function by identifying and applying the appropriate derivative formula.*

2.03 Find higher order derivatives.*

3. Understand the interpretation of derivatives and their applications in a business environment.

3.01 Interpret the derivative as a rate of change.*

3.02 Find the slope of the tangent line to the graph of a function at a given point.*

3.03 Use the first derivative to determine intervals on which the graph of a function is increasing or decreasing and to determine critical points of the function.*

3.04 Use the second derivative to determine intervals on which the graph of a function is concave upwards or concave downwards and to determine points of inflection.*

3.05 Find and classify relative extrema and, on a closed interval, absolute extrema of a function.*

3.06 Solve applied problems including marginal analysis applications.*

3.07 Explain the relationship between marginal cost and average cost.*

3.08 Determine and discuss the elasticity of demand for a product.

4. Understand the concept of integration and demonstrate ability to find indefinite and definite integrals apply those results to the business setting.

4.01 Construct antiderivatives analytically.*

4.02 Find indefinite integrals using integration formulas and the method of substitution.*

4.03 Find indefinite integrals using integration by parts.

4.04 Identify definite integrals of functions as the areas of regions between the graph of the function and the x-axis.*

4.05 Estimate the numerical value of a definite integral using a Riemann sum.

4.06 Understand and use the Fundamental Theorem of Calculus to evaluate definite integrals.*

4.07 Use definite integrals to calculate the area of the region under a curve and the area of the region between two curves.*
4.08 Determine present value and future value for an investment with interest compounded continuously.*

4.09 Determine the average value of a function on an interval.

4.10 For given supply and demand functions find and interpret the consumer's surplus and the producer's surplus.*

5. Demonstrate an understanding of functions of two variables

5.01 Find the domain of a function of two variables.

5.02 Interpret contour diagrams for functions of two variables.

5.03 Compute partial derivatives of functions of two variables algebraically.

5.04 Determine critical points for functions of two variables.

5.05 Use the second derivative test to determine the nature of critical points of a function of two variables.

5.06 Use the method of Lagrange multipliers to determine extreme values of functions of two variables subject to constraints.

5.07 Solve applied problems involving the Cobb-Douglas production functions.

TMM018 – Calculus III
(Implemented Winter 2010)

Typical Range: 4-5 Semester Hours

Approval for OMT018 Calculus III TAG course is required for inclusion in the Ohio Transfer Module as TMM018.

Specific learning outcomes for OMT018 is available at https://www.ohiohighered.org/transfer/tag/coursedescriptions

TMM019 – Elementary Linear Algebra
(Implemented Winter 2010)

Typical Range: 3-4 Semester Hours

Approval for OMT019 Elementary Linear Algebra TAG course is required for inclusion in the Ohio Transfer Module as TMM019.

Specific learning outcomes for OMT019 is available at https://www.ohiohighered.org/transfer/tag/coursedescriptions
TMM020 – Elementary Differential Equations
(Implemented Winter 2010)

Typical Range: 3-4 Semester Hours

Approval for OMT020 Elementary Differential Equations TAG course is required for inclusion in the Ohio Transfer Module as TMM020.

Specific learning outcomes for OMT020 is available at https://www.ohiohighered.org/transfer/tag/coursedescriptions
Learning Outcomes:
The course directly emphasizes at least one of the learning outcomes for the Transfer Module. Which of these learning outcomes are addressed and how?

- **Communicate effectively**: All general education programs include a component for writing; many also include a component for oral communication or presentation.
- **Evaluate arguments in a logical fashion**: Competence in analysis and logical argument are explicit learning goals for most general education programs, although these skills go by a variety of names (e.g., critical thinking, analysis, logical thinking, etc.).
- **Employ the methods of inquiry characteristic of natural sciences, social sciences, and the arts and humanities**: The tools for solving problems vary across disciplines; general education introduces students to methods of inquiry in several fields of study and thereby prepares students to integrate information from different disciplines.
- **Acquire an understanding of our global and diverse culture and society**
- **Engage in our democratic society**: One of the overarching goals of general education is to prepare students to be active and informed citizens, the development of a disposition to participate in and contribute to our democracy is full of equal importance to the goal of having the skills to do so intelligently.

**Guideline 1**: The course has the required entry level college proficiencies appropriate to the course. Entry level college proficiencies can be shown using a variety of means including placement exams, prerequisite coursework and a description of the course materials.

**Guideline 2**: Course is not remedial or developmental.

**Guideline 3**: Course does not cover variable content from term to term.

**Guideline 4**: Course is not a special topics course.

**Guideline 5**: Course is not an upper division course.

**Guideline 6**: Course is not a narrowly-focused technical or pre-technical course.

**Guideline 7**: Course has a primary focus on the performance of extemporaneous public speaking.

**Guideline 8**: Course clearly shows on the syllabus that a minimum of 51% points in the evaluation are from preparing and presenting extemporaneous speeches.

**Guideline 9**: Course covers the theory of oral communications.
Learning Outcomes:
The course directly emphasizes at least one of the learning outcomes for the Transfer Module. Which of these learning outcomes are addressed and how?

a. **Communicate effectively**: All general education programs include a component for writing; many also include a component for oral communication or presentation

b. **Evaluate arguments in a logical fashion**: Competence in analysis and logical argument are explicit learning goals for most general education programs, although these skills go by a variety of names (e.g., critical thinking, analysis, logical thinking, etc.)

c. **Employ the methods of inquiry characteristic of natural sciences, social sciences, and the arts and humanities**: The tools for solving problems vary across disciplines; general education introduces students to methods of inquiry in several fields of study and thereby prepares students to integrate information from different disciplines

d. **Acquire an understanding of our global and diverse culture and society**

e. **Engage in our democratic society**: One of the overarching goals of general education is to prepare students to be active and informed citizens, the development of a disposition to participate in and contribute to our democracy is full of equal importance to the goal of having the skills to do so intelligently.

**Guideline 1**: The course has the required entry level college proficiencies appropriate to the course. Entry level college proficiencies can be shown using a variety of means including placement exams, prerequisite coursework and a description of the course materials.

**Guideline 2**: Course is not remedial or developmental.

**Guideline 3**: Course does not cover variable content from term to term.

**Guideline 4**: Course is not a special topics course.

**Guideline 5**: Course is not an upper division course.

**Guideline 6**: Course is not a narrowly-focused technical or pre-technical course.

**Guideline 7**: Course is an introductory course that makes clear the importance of experimental inquiry in the sciences and the way in which such inquiry into the natural world leads scientists to formulate principles that provide universal explanations of diverse phenomena.

**Guideline 8**: Course helps the students to develop an understanding of structured thinking involving induction and deduction.

**Guideline 9**: Course is from natural science disciplines such as astronomy, biology, chemistry, environmental science, geology, physical geography or physics.

**Guideline 10**: The course has as a goal the development of an understanding of how scientific principles are built and used in the modern world and of the impact of science on society.
**Guideline 11:** The course does not focus exclusively on content coverage, without addressing the learning outcomes for the Transfer Module.

**Guideline 12:** Course has a laboratory component that has at least one credit hour and meets an average of no less than two hours per week.
Social and Behavioral Sciences
(Updated October 2008)

Learning Outcomes:
The course directly emphasizes at least one of the learning outcomes for the Transfer Module. Which of these learning outcomes are addressed and how?

a. Communicate effectively: All general education programs include a component for writing; many also include a component for oral communication or presentation

b. Evaluate arguments in a logical fashion: Competence in analysis and logical argument are explicit learning goals for most general education programs, although these skills go by a variety of names (e.g., critical thinking, analysis, logical thinking, etc.)

c. Employ the methods of inquiry characteristic of natural sciences, social sciences, and the arts and humanities: The tools for solving problems vary across disciplines; general education introduces students to methods of inquiry in several fields of study and thereby prepares students to integrate information from different disciplines

d. Acquire an understanding of our global and diverse culture and society

e. Engage in our democratic society: One of the overarching goals of general education is to prepare students to be active and informed citizens, the development of a disposition to participate in and contribute to our democracy is full of equal importance to the goal of having the skills to do so intelligently.

Guideline 1: The course has the required entry level college proficiencies appropriate to the course. Entry level college proficiencies can be shown using a variety of means including placement exams, prerequisite coursework and a description of the course materials.

Guideline 2: Course is not remedial or developmental.

Guideline 3: Course does not cover variable content from term to term.

Guideline 4: Course is not a special topics course.

Guideline 5: Course is not an upper division course.

Guideline 6: Course is not a narrowly-focused technical or pre-technical course.

Guideline 7: Course has content that allows the student to acquire an understanding of our global and diverse culture and society.

Guideline 8: Course is an introductory-level course that explains through empirical investigation and theoretical interpretation the behavior of individuals and/or various groups in societies, economics, governments or subcultures.

Guideline 9: Course is from either a social or behavioral science discipline, including anthropology, economics, geography, history, political science, psychology or sociology.

Guideline 10: Course employs the methods of inquiry characteristic of social and behavioral courses.