1. Demographic Information

Background

The Ohio Transfer Module (OTM), Subgroup 2, Mathematics, Statistics, and Logic have been tasked with exploring the possibility of a technical mathematics course(s) specializing in the application of mathematics for applied degree. This exploration roots in the future creation of Ohio Guaranteed Transfer Pathways (OGTP) for technical or applied degrees.

Proposed Technical Mathematics I (TMM014) were shared with the Ohio Mathematics Chairs/Leads and the Mathematics committee at the fall OTM Faculty Sub-Committee meeting including Subgroup 2 panel members. During these discussions it was identified that TMM014 would serve the following purposes:
- Act as the first (and possibly only) course in technical mathematics for two-year Associate of Applied Science (AAS) degrees.
- Serve as a pre-requisite for Technical Mathematics II (TMM015)
- Act as a general education course in the spirit of College Algebra that would serve specific programs/degrees that might want a technical-focused QR course.

Following these discussions the creation of Technical Mathematics II (TMM015) was formulated to serve the following purpose:
- Serve as a pre-calculus option for students interested in pursuing programs such as Engineering where mathematics courses in Calculus, Technical Calculus or Engineering specific Calculus courses are required.

Technical Mathematics I (TMM014) and Technical Mathematics II (TMM015) can serve as stand-alone courses within the OTM or account as a two-course sequence combining learning outcomes in TMM014 (Technical Mathematics I) and TMM015 (Technical Mathematics II). Though a course in Quantitative Reasoning (QR) is appropriate for most non-Calculus students, Technical Mathematics will benefit some majors/degrees/programs.

What We Need From You

Subgroup 2 seeks endorsement of the proposed learning outcomes for TMM014 and TMM0015 from the Ohio Mathematics Initiative Chairs/Leads Network. Please review proposed learning outcomes and coordinate efforts within your institution to complete the endorsement survey to determine if your institution agrees or disagrees with proposed course learning outcomes. We are collecting only one response per institution.

Please provide your institutional response by **Friday, February 7, 2020**. The survey link is: https://www.surveymonkey.com/r/93R5KJW

Thank you in advance for your assistance. If you have any questions, contact Jessi Spencer Director of OATN Policy, Budget, and Constituent Relations, as 614-728-4706 or jspencer@highered.ohio.gov.

* 1. Demographic Information about the Person Completing this Survey

Name	
Institution	
Department	
Title	
Email	
Phone	

* 2. Please Indicate the Type of Institution that you represent

- ◯ Two-Year Institution
- ◯ Four-Year Institution

2. Technical Mathematics I (TMM014)

Typical Range: 3-4 Semester Hours

A course in Technical Mathematics I specializes in the application of mathematics to the engineering technologies. The course emphasizes critical thinking by placing students in problem-solving situations and supporting students as they learn to make decisions, carry out plans, and judge results. Students encounter contextualized situations where concepts and skills associated with measurement, algebra, geometry, trigonometry, and vectors are the pertinent tools. The course highlights the supporting algebraic and analytical skills.

Rather than an Algebra course supplemented with applications, Technical Mathematics I (TMM014) is intended to follow the spirit of a Quantitative Reasoning course. Instead of lectures presenting skills and procedures followed by practice activities, we hope this course will place students in situations where the mathematics become the tools for investigation. Applications should be the foundation of a collaborative experience, where groups of students make decisions, choose tools, follow plans, draw conclusions, and explain their reasoning.

To qualify for TMM014 (Technical Mathematics I), a course must achieve all of the following essential learning outcomes listed in this document (marked with an asterisk).

1. Below are the learning outcomes for TMM014- Technical Mathematics I listed individually. Do you agree with these outcomes?

	Yes- should be essential	Yes- should be non-essential	No
1a: Recognize and apply properties of 2D shapes. Students recognize shapes within diagrams and use shapes in creating representations of situations. By selecting appropriate aspects and characteristics of the geometric shapes, students can extend a situational description via related lengths and areas. Through similar shapes and classifications, students explain their approach to problem solving. *	○	○	○
1b. Recognize and apply properties of 3D shapes. Students visualize 3D situations and navigate around the picture or diagram. Through the use of common 3D shapes,	○	○	○

students calculate volumes need for further calculations. *			
1c. Recognize and apply properties of angles. Student measures angles in degrees, radians, and DMS. Angular relationships, together with obtained or given angular measurements, are combined by student to elaborate about further angular measurements. *	○	○	○
1d. Apply the Pythagorean Theorem. The student can identify right angle triangles in a diagram and attribute given measurements to the proper aspects. With this information, the student can use the Pythagorean Theorem to deduce other measurements. *	○	○	○
2a. Reason with amount measurements. Students distinguish qualities, characteristics, and aspects of objects in situations that can be measured. They connect units with appropriate measurement type. They convert units, and abbreviations, for similar types of measurements and can properly use units when discussing measurements. *	○	○	○
2b. Reason with rate measurements. Students express rates as phrases, equations, and fractions. They compare the changing amounts described by rates. They can convert units and reason for the needed rate. *	○	○	○
2c. Can communicate about measurements. Students communicate fluently with units,			

abbreviations, and notation whether this be verbally or in writing. They calculate accurately with decimals, fractions, percentages, scientific notation, and engineering notation. They do so with information they have deciphered from tables and graphs. *	○	○	○
3a. Algebraically manipulate expressions and equations and inequalities. Students are fluent in the use of arithmetic and algebra rules, especially fractions. They predict effects of changes in variables. They solve equations for dependent variables. They model situations with linear and quadratic equations. *	○	○	○
3b. Combine algebraic and graphical representations. Students are proficient with all representations used to describe information and measurements. In particular, students competently use lines and linear equations to describe real-world relationships. *	○	○	○
3c. Solve systems of equations. Students can create systems of linear equations from given situations and then solve them via various techniques. *	○	○	○
3d. Row reduce a matrix. Students can row reduce an augmented matrix to solve systems of linear equations. *	○	○	○
4a. Explain representations of amounts and rates. Students express the meaning of the representational	○	○	○

fraction as a rate. *			
4b. Manipulates algebraic representations of amounts and rates. Students algebraically manipulate rates written as fractions. They can reduce and simplify products of rate fractions using the properties of exponents. *	○	○	○
5a. Identify right triangles in situations. Students identify right triangular configurations in diagrams and assign given measurements to the proper pieces of the triangles. *	○	○	○
5b. Apply trigonometric functions. Students identify which pieces of a right triangle are given and apply sine, cosine, and tangent functions to obtain further measurements. They use calculators to evaluate expressions involving trigonometric functions. They apply the Laws of Sine and Cosine appropriately. *	○	○	○
5c. Apply inverse trigonometric functions. Students recognize if questions are asking for lengths or angle measurements and can phrase a solution plan. Using calculators, students can obtain angular measurements from linear measurements. *	○	○	○
5d. Analyze and compare basic sine and cosine graphs. Students can graphically determine amplitude, period, phase shift, etc. *	○	○	○
6a. Represent vectors. Students represent vectors algebraically and graphically in either rectangular or	○	○	○

polar coordinates. *			
6b. Perform arithmetic with vectors. Students represent vectors algebraically and graphically and perform arithmetic operations in either mode. *	○	○	○
6c. Decompose vectors. Students decompose measurements into components relative to given coordinate systems. *	○	○	○
7a. Perform arithmetic with complex numbers. Add, subtract, multiply, and divide. *	○	○	○
7b. Connect algebraic expressions with points in the plane. a + bi associated with (a,b). *	○	○	○
7c. Map complex arithmetic with vector arithmetic. *	○	○	○
8a. Communicate via function notation. *	○	○	○
8b. Evaluate functions via formulas or graphs. *	○	○	○
8c. Obtain graphs via technology given formulas. *	○	○	○
8d. Analyze function behavior graphically. (increasing/decreasing, maximums/minimums). *	○	○	○
8e. Work explicitly with linear functions. *	○	○	○
8f. Work explicitly with quadratic functions. *	○	○	○
8g. Evaluate, graph, and graphically analyze exponential functions. *	○	○	○

2. Comments:

3. Technical Mathematics II (TMM015)

Typical Range: 3-4 Semester Hours

A course in Technical Mathematics II specializes in the application of mathematics to the engineering technologies. The course emphasizes critical thinking by placing students in problem-solving situations and supporting students as they learn to make decisions, carry out plans, and judge results. Students encounter contextualized situations where concepts and skills associated with measurement, algebra, geometry, trigonometry, and vectors are the pertinent tools. The course highlights the supporting algebraic and analytical skills.

Rather than an Algebra course supplemented with applications, Technical Mathematics II (TMMX015) is intended to follow the spirit of a Quantitative Reasoning course. Instead of lectures presenting skills and procedures followed by practice activities, we hope this course will place students in situations where the mathematics become the tools for investigation. Applications should be the foundation of a collaborative experience, where groups of students make decisions, choose tools, follow plans, draw conclusions, and explain their reasoning.

To qualify for TMM015 (Technical Mathematics II), a course must achieve all of the following essential learning outcomes listed in this document (marked with an asterisk).

1. Below are the learning outcomes for TMM015- Technical Mathematics II listed individually. Do you agree with these outcomes?

	Yes- should be essential	Yes- should be non-essential	No		
1a. Analyze basic polynomial functions. From a factored form, students identify zeros, multiplicities, locate and classify corresponding graph intercepts. From the graph or factorization, students discern locations of possible local maximums and minimums. Students produce graphs of polynomials given in factored form and describe the connection between zeros, factors, and intercepts. By examining the	○	○	○	○	○

factored form, students can predict polynomial end-behavior. *					
1b. Analyze basic rational functions. From a factored form, students identify zeros, poles, multiplicities, locate and classify corresponding graph intercepts and vertical asymptotes. From the graph or factorization, students discern locations of possible local maximums and minimums. Students produce graphs of rational functions given in factored form and describe the connection between zeros, factors, and intercepts and asymptotes. By examining the factored form, students can predict polynomial end-behavior and represent this graphically. *	○	○	○	○	○
1c. Analyze basic exponential functions. Students recognize basic exponential forms from formulas and graphs. Students explain general function properties and behavior and produce graphs from these. *	○	○	○	○	○
1d. Analyze basic logarithmic functions. Students recognize basic logarithmic forms from formulas and graphs. Students	○	○	○	○	○

explain general function properties and behavior and produce graphs from these. *					
1e. Analyze basic roots and radical functions. Students describe general function properties and behavior and produce graphs from these. *	○	○	○	○	○
1f. Analyze basic trigonometric functions. Students are fluent with the properties and behavior of sine, cosine, and tangent. Students identify zeros and their corresponding intercepts as well as asymptotes. Students provide exact values when appropriate and otherwise provide estimations. *	○	○	○	○	○
2a. Apply the distributive property effectively. Students decide when to factor or expand expressions to support a particular goal or enhance communication. Students identify common factors and construct equivalent products when seeking zeros. *	○	○	○	○	○
2b. Recognize algebraic structure. Students view expressions from the details of individual components to the patterns in which those components	○	○	○	○	○

are suspended. Students attend to the broad algebraic structure before addressing details. *					
2c. Students translate function characteristics and attributes to the reciprocal. *	○	○	○	○	○
2d. Manipulate exponents. Students condense, combine, and expand exponential expressions. *	○	○	○	○	○
2e. Manipulate logarithms. Students condense, combine, and expand logarithmic expressions. Students convert exponential-logarithmic compositions. *	○	○	○	○	○
2f. Manipulate radicals. Students condense, combine, and expand radical expressions. Students swap radical expressions for exponential expressions and vice-versa. *	○	○	○	○	○
2g. Utilize trigonometric identities. Students can use basic trigonometric identities to construct equivalent expressions. *	○	○	○	○	○
2h. Use algebraic properties in their analysis. Students make decisions on which algebraic properties to apply toward a goal and	○	○	○	○	○

judge their progress. Students add, subtract, multiply, and divide functions. *					
3a. Calculate rates of change over intervals. Students calculate rate-of-change and interpret. *	○	○	○	○	○
3b. Linearize a function around a point. Students plot tangent lines to graphs of functions and create linear functions that approximate the original function. *	○	○	○	○	○
3c. See rate-of-change as a function. Students sketch approximate graphs for rate-of-change of a function. Use these to describe function behavior. *	○	○	○	○	○
4a. Compose functions. Students compose functions algebraically. Students can identify component functions from a given composition. Students can establish domains and ranges of compositions. *	○	○	○	○	○
4b. View composition as an operation. Students view the identity function as the identity element in composition. Students can construct inverse functions and produce the identity function via composition. *	○	○	○	○	○

4c. Express linear composition graphically. Students interpret linear compositions in terms of graphical transformations. Students encapsulate graphical transformations algebraically. *	○	○	○	○	○
5a. Connect Cartesian equations and graphs of ellipses. Students can plot ellipses from equations. Students can create equations from plotted ellipses. *	○	○	○	○	○
5b. Parameterize ellipses. Students parameterize ellipses with sine and cosine. Students alter the trigonometric argument to change the parameterization without changing the curve.*	○	○	○	○	○
5c. Parameterize lines. Students create multiple parameterizations for the same line. *	○	○	○	○	○
5d. Interpret pieces of graphs as implicitly defined functions. Students can select domains and ranges to view a curve section as a graph of a function. Students can use an equation to evaluate a function defined implicitly. *	○	○	○	○	○

2. Additional Comments:

4. Survey Completion

Thank you for completing this survey!