Assessment #2 –Course Grades

Part 1 –Description of Assessment

Our candidates' grades on a set of required mathematics courses provide evidence that our candidates' meet NCTM CAEP Standard 1a. We have selected a set of our required courses for use in providing this evidence. The courses, listed below with their catalog descriptions, were selected because the courses are mathematics content courses. All but one of these courses are taken by both mathematics and mathematics education majors, and the expectations and requirements within the courses are the same for both groups of candidates. The content of the selected courses provides our candidates with the mathematics background required of a secondary mathematics educator. We chose not to include any courses that are more pedagogical in nature as we were interested in determining the achievement of our candidates regarding mathematics content. The tables found in the remainder of this document provide a more detailed alignment. We are including the description of a new course we are teaching for the first time this year. The course is titled "Advanced Perspectives on Secondary Geometry and Trigonometry" and is a required course for all mathematics education candidates beginning with those entering the program in Fall 2014. This course was designed to address an identified program weakness in the areas of geometry and trigonometry.

The documents related to this assessment are in three separate files due to the size of the files. This document includes parts 1 and 2a (Course alignment to NCTM/CAEP standards table). The alignment of our courses to the content addenda is included in a second document. Parts 3 and 4, university grade policy and data tables, are found in the third file.

Selected Course	Catalog Description
Math 1151 Calculus and Analytic Geometry I	This course is intended to develop an understanding of the basic concepts of plane analytic geometry, the limit process, continuity of functions, differentiation, integration, and areas under and between curves. It also provides an introduction to various applications of the calculus.
Math 1152 Calculus and Analytic Geometry II	This course provides a continuation of the study of topics from Math 1151.
Math 2410 Discrete Mathematics	The purpose of this course is to introduce students to basic structures and concepts that form the foundation for much of modern mathematics and to introduce various methods of proof.
Math 2221 Foundations of Geometry	A course with an emphasis on the techniques of proof and construction in geometry, the properties of a set of postulates, a brief review of Euclidean geometry, and the study of other geometries.
Math 2861 Advanced Perspectives on High School Mathematics	A course designed to help students investigate the real number system as studied in high school mathematics from an advanced perspective.
Math 2862 Advanced Perspectives on Secondary Geometry and Trigonometry	A course designed to help students recognize relationships between secondary geometry/trigonometry and university mathematics.
Math 3710 Linear Algebra	This course will provide an introduction to the concepts of linear transformation and vector space and their use in pure and applied mathematics.
Math 4710 Algebraic Structures	A study of groups, rings, and fields with an emphasis in the study of roots of polynomials.
Math 4851 Probability and Statistics for Middle/High School Mathematics	A course focusing on the concepts and methods of teaching probability and statistics in the middle and high school mathematics programs.
Math 4233 The Scientific, Historical, and Sociological Impact of Mathematics	Provides the opportunity to experience and understand the importance of mathematics in human development.

Part 2 – Course Alignment with NCTM/CAEP Standards

** As noted earlier, we are including a new course Math 2862 in the table. This course was designed to address identified program weaknesses in geometry and trigonometry.

NCTM/CAEP Standard Elements Addressed by Course	Course Number and Name	Course Components Addressing Standard Elements
Standard 1: Content Knowledge **Element 1a**	Math 1151 Calculus and Analytic Geometry I	The content of this course includes basic concepts of plane analytic geometry, the limit process, continuity of functions, differentiation, integration, and areas under and between curves. As this content is studied, candidates are provided multiple opportunities to demonstrate their knowledge of the major concepts, algorithms, and procedures of Calculus. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge. The course also provides an introduction to various applications of the calculus in the areas of business, economics, and physical sciences.
	Math 1152 Calculus and Analytic Geometry II	The content of this course includes the study of various techniques of integration, limits of the indeterminate forms, improper integrals, and approximation of functions by Taylor's polynomials, concepts of the polar coordinate system, the conic sections in polar and rectangular coordinates, vectors in the plane, parametric equations, vectors in three dimensional space, sequences, the concept of convergence, and infinite series.. As this content is studied, candidates are provided multiple opportunities to demonstrate their knowledge of the major concepts, algorithms, and procedures of Calculus. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge. Student learn problem -solving techniques in areas such as geometry, physics, and various

		real-world situations.
	Math 2221 Foundations of Geometry	The content of this course includes the study the techniques of proof and construction in geometry, the properties of a set of postulates, a brief review of Euclidean geometry, and the study of other geometries. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge. As an example of a course activity, as part of the course, students are assigned a surface and create their own system of geometry using that surface.
	Math 2410 Discrete Mathematics	The content of this course introduces students to the basic structures and concepts that form the foundation of much of modern mathematics. Students are introduced to various methods which they will apply in this and future courses. Students will study the basic mathematical concepts of logic, proofs, sets, relations, functions, and various topics from discrete mathematics. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge.
	Math 2861 Advanced Perspectives on High School Mathematics	The content of this course includes the study of the connections between high school and university mathematics, alternate ways of solving problems, connecting mathematical domains, and heavy emphasis on the features and uses of a variety of functions. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge. In this course, students solve and present their solutions to a wide variety of mathematical problems.
	Math 2862 Advanced Perspectives on Secondary Geometry and Trigonometry	The content of this course includes the study of connections between secondary geometry and trigonometry and university mathematics. Major topics include intuition and proof. Measurement, geometric transformations, study of triangles and circles, trigonometry, and an introduction to non-Euclidean geometry. Assignments and assessments used in the course provide evidence of the acquisition of this

		knowledge. As a major component of this course, students solve and present their solutions to a wide variety of problems in the area of geometry and trigonometry.
	Math 3710 Linear Algebra	The content of this course includes the study of the concepts of linear transformation and vector space and their use in pure and applied mathematics. Major topics include: systems of linear equations and matrices, determinants, vector spaces, linear transformations, Eigenvalues and Eigenvectors, and applications of these topics. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge.
	Math 4710 Algebraic Structures	The content of this course includes the study of basic algebraic systems such as groups, rings, and fields. The course will enable the student to broaden and develop his/her facility in mathematical abstraction while providing an algebraic perspective to familiar themes such as Euclidean geometry, polynomial algebra, and number theory. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge.
	Math 4851 Probability and Statistics for Middle/High School Mathematics	The content of this course includes theoretical and empirical probability, simulation, uses and misuses of statistics, organizing and representing data, correlation, regression, curve fitting, counting techniques, rules of probability, probability distributions, probability distribution functions, probability density functions, sampling and sampling distributions, confidence intervals, hypothesis testing, and the role of probability and statistics in the middle and high school curriculum. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge. As an example of a course activity, students complete a statistics project that involves them in designing a study and collecting, organizing, summarizing and presenting data.
	Math 4233	The content of this course includes the

	The Scientific, Historical, and Sociological Impact of Mathematics	historical development of mathematics, the relationships that exist among various topics in mathematics, the historical, scientific, sociological, cultural, and ethical factors that have influenced the development of mathematics, and the importance of various mathematicians and their contributions to the development of mathematics. Assignments and assessments used in the course provide evidence of the acquisition of this knowledge. Students research and provide presentations on a variety of mathematicians and historical mathematical events. They create a problem-solving portfolio in which they demonstrate their ability to solve a variety of mathematical problems.

NCTM/CAEP Standard Elements Addressed by Course	Course Number and Name	Course Components Addressing Standard Elements
Element 2a Use problem solving to develop conceptual understanding, make sense of a wide variety of problems and persevere in solving them, apply and adapt a variety of strategies in solving problems confronted within the field of mathematics and	MATH 1151 Calculus and Analytic Geometry I	Students are expected to do problem solving related to nearly every concept. For example, derivatives are used to solve problems related to velocity, acceleration, related rates and optimization. Multiple strategies are used in solving many of these problems. Optimization problems may involve solving equations, hand drawn graphs, graphing utilities and differentiation. Problems in Calculus I come from many contexts including business (e.g. finding maximum profit), engineering (e.g. finding the least expensive route for a pipe), biology (e.g. finding the rate of spread of disease), physics (e.g. finding centers of mass) and many other fields.
	MATH 1152 Calculus and Analytic Geometry II	Students solve problems every day, some more applied than others. Multiple problem solving strategies are used in techniques of integration. Sometimes a single integral may require multiple techniques. In addition, students may solve or gain insight into a definite integral using graphs or integration

other contexts, and formulate and test conjectures in order to frame generalizations.		technology on a calculator or computer program. Applied problems may involve finding the area of unusually shaped objects, finding the center of mass of an object, etc. Multiple strategies are also required in studying infinite series. Determining whether a series converges or not generally includes applying some logical tests. Students apply different strategies depending on the type of series. Multiple strategies are also used when studying integration techniques. Problems in Calculus II, come from a variety of fields including physics, engineering, geometry, and astronomy
	Math 2410 Discrete Mathematics	In this course students learn the art of forming conjectures about mathematical relationships and proving under what conditions these relationships hold. This is accomplished by considering many examples, noticing patterns, testing these patterns with additional examples, and, finally, constructing an argument which shows that the pattern holds in general. Through doing so, students develop both an intuitive and a rigorous approach to solving problems involving *what* relationships hold and *when, why* and *how* they hold. Problems in this course come from the fields of set theory and combinatorics (counting), number theory (e.g. divisibility and factorization), and functions and relations (how to relate one structure to another). The analytical and relational habits of thought formed in this course apply to essentially every experience the student will have in life, and in particular when they ask: Is this statement true? What conditions are necessary for it to be true? Is it always true? Why is it true?
	Math 3710 Linear Algebra	Students solve problems by performing computations with linear systems, calculating determinants and solutions to linear systems of equations, and showing conceptual understanding by using properties of those procedures to solve problems about linear systems. Students make and test conjectures in determining whether defined

		sets are vector spaces, and whether defined functions are linear transformations. Students use not only the procedure of computing in linear systems, but also use the concepts of the properties of those computations to solve problems (eg. the row reduction properties are used in arguments about determinants and linear independence). Students generalize computations and computational procedures to prove properties about linear spaces and transformations.
	Math 2221 Foundations of Geometry	Students use problem solving throughout the course. They use construction tools as well as computer software to solve a variety of problems. Students create a system of geometry on an alternate surface such as a doughnut, volcano, or sphere and problem solve to see what figures exists and the properties of these figures, and then substantiate properties and relationships.
	Math 4710 Algebraic Structures	In this course students hone their logical, analytical and proof-writing skills by addressing the concept of abstraction in mathematical thought. Students consider properties shared by large classes of objects (integers, functions, matrices, etc.), and find relationships and further properties that are implied by the basic definitions. This is a course that emphasizes the *discovery* of relationships required by *invented* and *abstracted* structures. The habits of thought developed in this course contribute to the powerful problem solving techniques of abstraction, generalization, and deduction. In particular, students are introduced to the idea that in order to solve a specific concrete problem, it is sometimes easier to generalize and abstract, to come to the root of the question, and then solve the problem from a more theoretical viewpoint.
NCTM/CAEP Standard Elements Addressed by Course	**Course Number and Name**	**Course Components Addressing Standard Elements**

Element 2b Reason abstractly, reflectively, quantitatively with attention to units, constructing viable arguments and proofs, and critiquing the reasoning of others; represent and model generalizations using mathematics; recognize structure and express regularity in patterns of mathematical reasoning; use multiple representations to model and describe mathematics; and utilize mathematical vocabulary and symbols to communicate mathematical ideas to others.	Math 1151 Calculus and Analytic Geometry I	Students must reason abstractly and construct a viable proof when proving limits of functions. They also reason abstractly as we present limit theorems, derivative theorems and many other generalizations. For example, we start by finding the derivative of a power function using the definition of the derivative, but soon realize there is a pattern evolving. So, we make a conjecture about derivatives of powers and then prove the theorem. Students use multiple representations in many ways. One example would be finding the limit of a function. Students represent a limit using a table of values, a graph and symbolically by applying limit theorems. Throughout calculus, students are required to use correct vocabulary and symbols to represent things such as limits, derivatives and integrals. They are also required to pay attention to units in application problems. In fact, in related rate problems, for example, paying attention to units can often guide the solution or provide a check for the final solution.
	Math 1152 Calculus and Analytic Geometry II	Students must reason abstractly in much of Calculus II. Constructing viable arguments is particularly important in applying infinite series tests. Critiquing the reasoning of others is done informally as students work together on projects and compare answers to homework problems. Multiple representations are used when studying integration techniques, conic sections, and vectors. Students are required to use appropriate vocabulary and symbols throughout the course.
	Math 2410 Discrete Mathematics	This standard could be used as a description of the course. Students study proof techniques from the standpoint of conjecture, example and counterexample, and formal proof. Throughout, the emphasis is on understanding patterns, generalizing, constructing logical arguments via chains of more simple deductions, and clearly communicating both the statements and their proofs. Students observe and participate in

		instructor-created proofs, create their own proofs, present their proofs to their peers and the instructor, critique their own and others' proofs, and use the proven theorems to perform calculation and generate further conjectures.
	Math 3710 Linear Algebra	Students create and share mathematical arguments, proofs and counterexamples in the context of vector spaces and linear transformations. Students solve problems and write mathematical arguments about transformations, coordinates and coordinate systems and vectors.
	Math 2221 Foundations of Geometry	Proof is a major part of this course. Students are introduced to various types of proofs and students compare and contrast informal and formal proof as well as inductive and deductive proofs. Students are provided completed proofs that have been cut into parts and they must reconstruct the proof and provide arguments for how they reconstructed them.
	Math 4710 Algebraic Structures	Groups, rings and fields are the abstract structures that represent recurring patterns of behavior in mathematical and real-world experience. Students recognize and formalize these structures with axiomatic definitions and via homomorphisms that illuminate similarities between structures. Moreover, students rigorously justify conclusions about additional properties of structures using the techniques and vocabulary of mathematical reasoning.
NCTM/CAEP Standard Elements Addressed by Course	**Course Number and Name**	**Course Components Addressing Standard Elements**
	Math 1151 Calculus and Analytic Geometry I	Students are required to formulate, represent, analyze and interpret mathematical models from business (e.g. finding maximum profit), engineering (e.g. finding the least expensive route for a pipe), biology (e.g. finding the rate of spread of disease), physics (e.g.

Element 2c Formulate represents, analyze, and interpret mathematical models derived from real-world contexts or mathematical problems.		finding centers of mass) and many other fields. In some problems the student is required to formulate the model and in some cases the model is given, but in each case the student must analyze and interpret the model. This course includes many applied models, many of the same mathematical concepts and models are also studies from a purely mathematical. Such topics and models include differentiation techniques, limit techniques, and basic integration techniques.
	Math 1152 Calculus and Analytic Geometry II	Students are required to formulate, represent, analyze and interpret mathematical models from a variety of fields including physics (e.g. velocity and acceleration in parametric equations), engineering (e.g. finding angles and magnitude of force), and astronomy (e.g. finding orbits of planets). In some problems the student is required to formulate the model and in some cases the model is given, but in each case the student must analyze and interpret the model. This course also involves many mathematical models which focus on purely mathematical problems, such as finding volumes, surface areas, arc length and curvature. Although these topics have applications, many of the problems we work on are purely mathematical rather than applied.
	Math 2410 Discrete Mathematics	Students derive and justify formulae that hold in very general settings. Though most problems addressed in this course are abstracted from large classes of real-world problems, some topics (notably combinatorics and probability) lend themselves to direct applications. Skills, techniques and theorems developed in this course support the application of mathematics across the curriculum. In particular, it is often in this course that students first learn to mathematics as more than solving equations and performing various computations. They learn that many

		familiar objects and topics can be approached from a mathematical viewpoint.
	Math 3710 Linear Algebra	Students formulate represents, analyze and interpret models in a variety of ways in this course. Students apply, analyze and describe linear transformations, vectors, coordinates and coordinate systems. Students use vectors and matrices to analyze and describe lines, planes and subspaces in two, three and higher dimensions. Students use linear algebra techniques to analyze lines, planes and spaces from a vector standpoint.
	Math 2221 Foundations of Geometry	Students taxicab geometry and the properties and relationships that exist. They solve a variety of real-world problems in the area of geometry.
	Math 4710 Algebraic Structures	The formal structures studied in this course are the result of abstraction from numerous historical problems: finding roots of polynomials, determining symmetries of geometrical objects, etc. Throughout the course this historical motivation is referenced and the general and abstract techniques are applied to these problems. Moreover, the rigorous treatment of hypothesis and conclusion in the course allows precise and appropriate use of the theory in other courses and in work outside the classroom.
NCTM/CAEP Standard Elements Addressed by Course	**Course Number and Name**	**Course Components Addressing Standard Elements**
Element 2d Organize mathematical thinking and use	Math 1151 Calculus and Analytic Geometry I	Students must organize their mathematical thinking as they work homework problems and solve problems on the tests. On tests and homework they must express their ideas precisely in writing. They express their ideas orally during discussions in class and as they work on group projects.
	Math 1152 Calculus and Analytic	Students must organize their mathematical thinking as they work homework problems

the language of mathematics to express idea precisely, both orally and in writing to multiple auidences.	Geometry II	and solve problems on the tests. On tests and homework they must express their ideas precisely in writing. They express their ideas orally during discussions in class and as they work on group projects.
	Math 2410 Discrete Mathematics	In addition to being an introduction to discrete mathematical structures, this course is an introduction to mathematical proof, i.e., the language by which mathematical reasoning is expressed. Students learn to develop lines of logical reasoning and to write them clearly, succinctly, and with appropriate mathematical notation. They practice communicating with the instructor and with each other through homework assignments and board work, and are additionally graded on their communication skills through regular examination. Feedback on the appropriateness of student communication is given ate frequent intervals, and students are encouraged to view their communication as a recursive process where they make one or more revisions before giving a final clear and concise solution/proof.
	Math 3710 Linear Algebra	Students write mathematical arguments and construct counterexamples on linear algebra topics including establishing identities, and identifying vector spaces and linear transformations. Students present their mathematical arguments visually and in writing, using language and symbolism in vectors, matrices, and linear transformations.
	Math 2221 Foundations of Geometry	Students in this course create mathematical arguments and proofs and communicate these both verbally and in writing. They listen to and critique those arguments provided by other students. The students work in pairs to create a system of geometry on a provided surface such as a doughnut or hubcap. They must prove the properties and relationships that exist and present their work to the class.
	Math 4710 Algebraic Structures	This proof-based course requires students to develop and practice their reasoning and communication skills in all course activities.

		Assigned readings and problems, oral presentations to the class, and regular examinations all depend completely on the students' ability to communicate mathematics effectively. In this course, students learn that often times, the method and solution is more important than the final answer. Therefore, the clear communication of the method and/or proof is emphasized. Students receive a great deal of feedback from their instructor and throughout the course learn to improve their skills of mathematical communication.
NCTM/CAEP Standard Elements Addressed by Course	**Course Number and Name**	**Course Components Addressing Standard Elements**
Element 2e Demonstrate the interconnectedness of mathematical ideas and how they build on one another and recognize and apply connections among mathematical ideas and across various content areas and real-world contexts.	Math 1151 Calculus and Analytic Geometry I	In Calculus I students take concepts that they know from algebra and run them through a limiting process to build new concepts. For example, in algebra students learn how to find the area of a rectangle. In Calclulus I, we use the area of rectangles and a limiting process to find the area under a curve. Here, students recognize how mathematical ideas build on one another. In calculus, students recognize connections among algebra, geometry, trigonometry and calculus and how these are related to content areas such as economics, engineering, physics, business, biology and social sciences.
	Math 1152 Calculus and Analytic Geometry II	In Calculus II, students continue to build connections between algebra, geometry, trigonometry and calculus, as well as other content fields and real-world contexts such as economics, engineering, physics, business, biology and social sciences.
	Math 2410 Discrete Mathematics	This course reintroduces students to various discrete structures such as sets, integers, and functions. Though they have seen these structures many times before in their mathematical education, this rigorous approach enriches and extends the mathematical definitions, techniques and theorems that they have worked with since

		elementary school. Students develop new insights about these familiar structures and find new ways to express these insights with advanced mathematical vocabulary, notation, and techniques.
	Math 3710 Linear Algebra	Students integrate their knowledge from previous courses in algebra with the new matrix and vector space techniques they are learning. Students use their numerical and algebraic computation skills in solving linear algebra problems. Students demonstrate knowledge of connections between geometry and algebra in their work with low dimensional vector spaces. Students study rotations, reflections and dilations in the context of linear transformations, and translate between the geometric and matrix form of these transformations. Students represent low dimension vector spaces both geometrically and algebraically, and translate between these contexts. Students use vectors and matrices as systems that have some of the properties of the real-number systems.
	Math 2221 Foundations of Geometry \	Students in this course use the definitions they have previously worked with and explore how a change in the definition impacts the outcome. Students use logic and proof types from other areas of mathematics and apply those to situations involving geometry.
	Math 4710 Algebraic Structures	The structures developed in the course (groups, rings and fields) express the patterns that have occurred in many or all of their previous and future mathematics courses, and in other technical and scientific fields. A strong emphasis on examples from a variety of mathematical and technical fields helps students develop intuition into the abstract structures themselves, as well as recognize connections between the disparate fields. In particular, through generalizing and

		abstracting, students are able to see that many familiar objects fall under a general setting and can be studied simultaneously.
NCTM/CAEP Standard Elements Addressed by Course	**Course**	**Course Components Addressing Standard Elements**
Element 2f Model how the development of mathematical understanding within and among mathematical domains intersects with the mathematical practices of problem solving, reasoning, communicating, connecting, and representing.	Math 1151 Calculus and Analytic Geometry I	Throughout the course students use the mathematical practices as they learn new concepts. For each concept, they represent the idea in multiple ways (e.g. limits are represented using graphs, tables of values and algebraically), they must use the representations to correctly reason about the concept, and communicate their reasoning verbally (in-class discussions) and in writing (on homework and tests). In addition, problem solving is incorporated along the way with each new concept. For example, after a discussion on integration, the students are expected to be able to apply the concepts to problems they haven't seen, including applications such as area under a curve and center of mass.
	Math 1152 Calculus and Analytic Geometry II	Throughout the course students use the mathematical practices as they learn new concepts. For each concept, they represent the idea in multiple ways (e.g. vectors can be represented graphically or algebraically), they must use the representations to correctly reason about the concept, and communicate their reasoning verbally (in-class discussions) and in writing (on homework and tests). In addition, problem solving is incorporated along the way with each new concept. For example, after a discussion of cross products and dot products of vectors, students use the concepts to find equations of lines and planes in space.
	Math 2410 Discrete Mathematics	In this course students learn about various discrete structures as well as various mathematical tools and proof techniques. Beginning with straightforward mathematical objects, students learn about methods of proof. As more involved notation

		and proof techniques are developed, students are able to consider more complicated objects. The computations and studies of sets and functions lead to the development of new algorithms and methods of proof. In turn, these algorithms and proof techniques allow for more interesting objects to be introduced and studied.
	Linear Algebra	Linear algebra allows students work with important multivariable problems and provides students with general-purpose matrix methods that will serve them well in many fields, including mathematics, science, engineering, computer science, and economics. Students learn to represent situations that involve variable quantities with expressions, equations, and matrices; use tables and graphs as tools to interpret expressions and equations; operate on expressions and matrices, and solve equations and inequalities; Students develop an understanding of properties of, and representations for, the addition and multiplication of vectors and matrices. Students use geometric properties (sub-spaces which are parallel or perpendicular or projections onto subspaces) and connect these to the corresponding vector calculations using expressions and equations in linear systems.
	Math 2221 Foundations of Geometry	In this course, students use the mathematical practices as they learn new content. New content is developed through the use of the practices. Reasoning is used to create proofs, problem solving is used in the creation of new geometry systems, connections are made between definitions and these new systems, and communication of idea occurs both orally and in writing.
	Math 4710 Algebraic Structures	In this course students learn about algebraic structures such as groups, rings, and fields. They also learn about various mathematical

		tools such as permutations and homomorphisms, and learn new proof techniques using these tools. Beginning with familiar examples of algebraic objects, students learn about these tools and proof techniques. As more involved tools and techniques are developed, students are able to consider more complicated and interesting algebraic objects. The study of objects of increasing complexity complements the study of more involved techniques and methods of proof.

NCTM CAEP Standards (2012) Content Alignment Table – Secondary

(Supporting *Documenting Course Grades as an Assessment of Candidate Content Knowledge*)

Instructions:
Completion of this mathematics content alignment table is one of the required components of the documentation requirements for programs using course grades as an assessment. This document is designed as a form and must be used for entering required information into each "Click here to enter text" box, which will expand as needed. Do not retype the form. Since this form is a template, it will open as a document to be renamed and saved upon completion. Separate forms by program level (e.g., undergraduate or graduate) and program type (e.g., MAT or M. Ed.) are required. Specific directions for completing the form based on the location of mathematics/mathematics education coursework completion follow:

Undergraduate Programs and Graduate Programs where Mathematics/Mathematics Education Coursework Taken at Submitting Institution

- Column 2: Specify selected course number(s) and name(s) of **required** coursework that addresses each competency listed in the first column. If no required coursework addresses a specific competency, enter "Not addressed."

- Column 3: Describe all technology and representational tools, including concrete models, used in **required** courses that address each competency listed in the first column. If required coursework does not include the use of technology and representational tools, enter "Not included."

- Column 4: Include course description(s) for all **required** courses listed in the second column. It is sufficient to include course descriptions by mathematical domain (e.g., algebra, statistics and probability) rather than by individual competency.

Graduate Program where Mathematics/Mathematics Education Coursework Taken at Another (Non-Submitting) Institution

- Column 2: Specify selected course number(s) and name(s) of **required** undergraduate coursework that addresses each competency listed in the first column. Describe the advising decision that ensures program completers have studied the required mathematics content. If no required coursework addresses a specific competency, enter "Not addressed."

- Column 3: Describe all technology and representational tools, including concrete models, used in **required** courses that address each competency listed in the first column. If not known, do not leave the cell blank; rather, enter "Not verifiable".

- Column 4: Include course description(s) for all **required** courses listed in the second column. It is sufficient to include course descriptions by mathematical domain (e.g., algebra, statistics and probability) rather than by individual competency.

- Include the transcript analysis form that is used by the program to determine sufficiency of undergraduate courses taken by a program candidate at another institution and to specify coursework required to remediate deficiencies in the mathematics acquirement of program candidates or completers. The transcript analysis process must adhere to the *Guidelines for Documenting a Transcript Analysis*.

Institution Name	University of Central Missouri
Program Name	BSE Mathematics
Program Type (e.g., Baccalaureate or M.Ed.)	Baccalaureate

A. Secondary Mathematics Teachers

All secondary mathematics teachers should be prepared with depth and breadth in the following mathematical domains: Number, Algebra, Geometry, Trigonometry, Statistics, Probability, Calculus, and Discrete Mathematics. All teachers certified in secondary mathematics should know, understand, teach, and be able to communicate their mathematical knowledge with the breadth of understanding reflecting the following competencies for each of these domains.

A.1. Number and Quantity To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to number and quantity with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models:	**Required Course Number(s) and Name(s)**	**Technology and Representational Tools Including Concrete Models by Competency**	**Course Description(s)**
A.1.1 Structure, properties, relationships, operations, and representations including standard and non-standard algorithms, of numbers and number systems including integer, rational, irrational, real, and complex numbers	MATH 2861 – Advanced Perspectives on High School Mathematics MATH 2410 - Discrete Mathematics	Graphing calculators and models such as counters and numberlines for developing integers	MATH 1151 – Topics include: limits and continuity, finding limits and formal definitions of limits, one-sided and infinite limits, derivative, the derivative of a function and tangent lines, differentiation rules, rates of change, derivatives of trigonometric functions, differentiation of composite and implicit functions, differentiation of rational powers of functions, related rates, applications of
A.1.2 Fundamental ideas of number theory (divisors, factors and factorization, primes, composite numbers, greatest common factor, least common multiple, and modular arithmetic)	MATH 2861 - Advanced Perspectives on High School Mathematics MATH 2410 – Discrete Matheatmics	NCTM Illuminations website, factor game, National Library of Virtual Manipulatives, Sieve of Erathosenes	
A.1.3 Quantitative reasoning and relationships that include ratio, rate, and proportion and the use of units in problem situations	MATH 2221 – Foundations of Geometry MATH 2861 – Advanced Perspectives on High School	Motion dectectors, GeoGebra	

	Mathematics MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry MATH 1151 – Calculus and Analytic Geometry I MATH 1152 - Calculus and Analytic Geometry II		derivative, extreme values of functions the Mean Value Theorem, the first derivative test, limits at infinity and asymptotes of a graph, optimization and differentials, integration, indefinite integrals and differential equations, integration by substitution, the definite integral, properties of definite integral, applications to area, the Fundamental Theorem of Calculus, substitution in definite integrals and numerical integration, inverse functions and their derivatives, natural logarithm function, natural exponential functions, growth and decay, inverse trigonometric functions, hyperbolic functions, applications of integrals, areas between curves, volumes of solids of revolution, finding volumes by slicing, arc length, areas of surfaces of revolution and work, moments and centers of mass MATH 1152 – Topics include: techniques of integration (by parts, by trigonometric substitution, of powers
A.1.4 Vector and matrix operations, modeling, and applications	MATH 3710 - Linear Algebra	Graphing calculators, iPads	
A.1.5 Historical development and perspectives of number, number systems, and quantity including contributions of significant figures and diverse cultures	MATH 4233- Scientific, Historical, and Sociological Impact of Mathematics	Variety of internet sources, power point for student presentations, YouTube videos to illustrate concepts	

			of trigonometric functions, of rational functions by partial fractions, improper integrals), sequences and convergence of sequences, bounded sequences and monotonic sequences, infinite series of positive terms, alternating series and their convergence, absolute and conditional convergence of series, the integral test, root test, ratio test, introduction to power series, differentiation and integration of power series, Taylor's series, binomial series, conic sections, quadratic equations, rotations, classifying conic sections by eccentricity, parametrizations of plane curves and calculus of parametrized curves, polar coordinates and graphing in polar coordinates, polar equations for conic sections, integration in polar coordinates, vectors in three dimensional space and solid geometry, vectors in the plane, vectors in space, dot products and cross products, lines and planes in space,

			cylinders and quadratic surfaces, cylindrical and spherical coordinates, vector-valued functions and space curves, unit tangent and unit normal vectors, arc length as the parameter for curves, curvature, torsion, TNB frame, plane motion MATH 2221- Topics include: axioms and postulates in geometry, role of definitions, role of axioms, role of postulates, axioms of connection, axioms of betweeness, axioms of congruence, axioms of continuity, types and formats of proofs, validity of propositions in Euclid's Elements, equivalent and alternate forms of Euclid's fifth postulate, similarity, Euclidean results concerning circles, Euclidean results concerning triangles, constructions in Euclidean geometry, philosophy of construction, basic constructions in Euclidean geometry MATH 2410 – Topics include: basic concepts of logic, direct proofs, proofs

			by counterexample, proofs by contraposition, proofs by contradiction, constructive and nonconstructive proofs, mathematical induction, basic concepts of sets, set operations, Venn diagrams, containments and equality, mappings and their properties, cardinality and countability, Cartesian products and relations, division algorithm, Euclidean algorithm, modular arithmetic, pigeonhole principle, permutations, combinations, binomial theorem and Pascal's triangle, the principle of inclusion-exclusion, discrete probabilities, conditional probabilities, random variables and expectation, recurrence relations, generating functions, graphs, trees, Boolean algebra MATH 2861 – Topics include: definition of functions, historical evolutions of functions, basic machinery of functions, properties of real functions, problems involving real functions, concept

			of equation, algebraic structures and solving equations, the solving process, congruence, Euclid and congruence, the congruence transformations, symmetry, distance, similar figures, distances within figures, trigonometry, angle measure and the trigonometric ratios, the trigonometric functions and their connections, properties of the sine and cosine functions MATH 2862 – Topics include: direct proof, proof by contradiction, proof by counterexample, proof by induction, similarity, area of simple figures, the circle, areas of irregular shapes, volume, geometric transformations, functions, the matrix approach, transforming areas, transformations in three dimensions, laws of sine and cosine, similarity, Heron's Theorem, right triangle trigonometry, radian measure, graphing trigonometric curves, modeling with trigonometric functions, inverse trigonometric

			functions, trigonometric identities, vectors, introduction to non-Euclidean geometry, the Parallel Postulate, undefined terms MATH 3710 – Topics include: vector and matrix algebra, the solution of systems of equations, the inverse of a square matrix, determinants, definition and basic properties of determinants, applications of the determinant, introduction to Vector Space, definition and terminology of vector spaces, basis and dimension of a vector space, the kernel, nullity and rank of a matrix, linear transformations, definition of linear transformation and the concept of isomorphic vector space, the kernel and range of a linear transformation, the transformation matrix of a linear transformation, vector space isomorphism, characterization of finite dimensional vector spaces, the characteristic polynomial of a matrix, definition of eigenvalues and eigenvectors,

			applications of eigenvalues and eigenvectors MATH 4233 – Topics include: early numeration systems, Babylonian and Egyptian mathematics, Greek mathematicians up to Euclid, Greek mathematicians beyond Euclid, Euclidean geometry, Chinese mathematics, Hindu mathematics, Arabian mathematics, European mathematics, modern mathematics

A.2. Algebra To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to algebra with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models:	**Required Course Number(s) and Name(s)**	**Technology and Representational Tools Including Concrete Models by Competency**	**Course Description(s)**
A.2.1 Algebraic notation, symbols, expressions, equations, inequalities, and proportional relationships, and their use in describing, interpreting, modeling, generalizing, and justifying relationships and operations	MATH 2861 - Advanced Perspectives on High School Mathematics MATH 1151 – Calculus and Analytic Geometry I	GeoGebra software, graphing calculators, algebra tiles, NCTM Illuminations, and function modeling	MATH 1151 – Topics include: limits and continuity, finding limits and formal definitions of limits, one-sided and infinite limits, derivative, the derivative of a function and tangent lines, differentiation rules, rates of change, derivatives of trigonometric functions,
A.2.2 Function classes including polynomial, exponential and logarithmic, absolute value, rational, trigonometric, including those with discrete domains (e.g., sequences), and how the choices of parameters determine	MATH 1151 - Calculus and Analytic Geometry I MATH 1152 - Calculus and Analytic Geometry II MATH 2861 –	Graphing calculators, spaghetti models of functions	

particular cases and model specific situations	Advanced Perspectives on High School Mathematics		differentiation of composite and implicit functions, differentiation of rational powers of functions, related rates, applications of derivative, extreme values of functions the Mean Value Theorem, the first derivative test, limits at infinity and asymptotes of a graph, optimization and differentials, integration, indefinite integrals and differential equations, integration by substitution, the definite integral, properties of definite integral, applications to area, the Fundamental Theorem of Calculus, substitution in definite integrals and numerical integration, inverse functions and their derivatives, natural logarithm function, natural exponential functions, growth and decay, inverse trigonometric functions, hyperbolic functions, applications of integrals, areas between curves, volumes of solids of revolution, finding volumes by slicing, arc length, areas of surfaces of revolution and work, moments
A.2.3 Functional representations (tables, graphs, equations, descriptions, recursive definitions, and finite differences), characteristics (e.g., zeros, intervals of increase or decrease, extrema, average rates of change, domain and range, and end behavior), and notations as a means to describe, reason, interpret, and analyze relationships and to build new functions	MATH 1151 - Calculus and Analytic Geometry I MATH 1152 - Calculus and Analytic Geometry II MATH 2861 – Advanced Perspectives on High School Mathematics	Graphing calculators, GeoGebra, NCTM Core Math Tools	
A.2.4 Patterns of change in linear, quadratic, polynomial, and exponential functions and in proportional and inversely proportional relationships and types of real-world relationships these functions can model	MATH 1151 - Calculus and Analytic Geometry I MATH 1152 – Calculus and Analytic Geometry II MATH 2861 – Advanced Perspectives on High School Mathematics	Graphing Calculators, GeoGebra, motion detectors	
A.2.5 Linear algebra including vectors, matrices, and transformations	MATH 371 0 - Linear Algebra	Graphing calculators, iPads	
A.2.6 Abstract algebra, including groups, rings, and fields, and the relationship between these structures and formal structures for number systems and numerical and symbolic calculations	MATH 4710 - Algebraic Structures	Computer Algebra System – MATLAB or SAGE	
A.2.7 Historical development and perspectives of algebra including contributions of significant figures and diverse cultures	MATH 4233 - Scientific, Historical, and Sociological Impact of Mathematics	A variety of internet sources, power point for student presentations, YouTube videos to illustrate concepts	

			and centers of mass MATH 1152 – Topics include: techniques of integration (by parts, by trigonometric substitution, of powers of trigonometric functions, of rational functions by partial fractions, improper integrals), sequences and convergence of sequences, bounded sequences and monotonic sequences, infinite series of positive terms, alternating series and their convergence, absolute and conditional convergence of series, the integral test, root test, ratio test, introduction to power series, differentiation and integration of power series, Taylor's series, binomial series, conic sections, quadratic equations, rotations, classifying conic sections by eccentricity, parametrizations of plane curves and calculus of parametrized curves, polar coordinates and graphing in polar coordinates, polar equations for conic sections, integration in polar coordinates, vectors in three

			dimensional space and solid geometry, vectors in the plane, vectors in space, dot products and cross products, lines and planes in space, cylinders and quadratic surfaces, cylindrical and spherical coordinates, vector-valued functions and space curves, unit tangent and unit normal vectors, arc length as the parameter for curves, curvature, torsion, TNB frame, plane motion MATH 2861 – Topics include: definition of functions, historical evolutions of functions, basic machinery of functions, properties of real functions, problems involving real functions, concept of equation, algebraic structures and solving equations, the solving process, congruence, Euclid and congruence, the congruence transformations, symmetry, distance, similar figures, distances within figures, trigonometry, angle measure and the trigonometric ratios, the trigonometric functions and their connections, properties of the sine and cosine

			functions MATH 3710 – Topics include: vector and matrix algebra, the solution of systems of equations, the inverse of a square matrix, determinants, definition and basic properties of determinants, applications of the determinant, introduction to Vector Space, definition and terminology of vector spaces, basis and dimension of a vector space, the kernel, nullity and rank of a matrix, linear transformations, definition of linear transformation and the concept of isomorphic vector space, the kernel and range of a linear transformation, the transformation matrix of a linear transformation, vector space isomorphism, characterization of finite dimensional vector spaces, the characteristic polynomial of a matrix, definition of eigenvalues and eigenvectors, applications of eigenvalues and eigenvectors MATH 4233 – Topics include: early numeration systems,

			Babylonian and Egyptian mathematics, Greek mathematician up to Euclid, Greek mathematicians beyond Euclid, Euclidean geometry, Chinese mathematics, Hindu mathematics, Arabian mathematics, European mathematics, modern mathematics MATH 4710 – Topics include: group theory, abstract groups, cyclic groups, modular groups, symmetric groups, dihedral groups, groups of isometries, matrix groups, subgroups, normality, Lagrange's Theorem, quotient groups, homomorphisms, the First Isomorphism Theorem, rings, fields, abstract rings, integers and extensions, polynomials rings, ideals, quotient rings, unique factorization, number theory, group actions, finite fields

A.3. Geometry and Trigonometry To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to geometry and trigonometry with their content understanding and mathematical practices supported by appropriate technology and	**Required Course Number(s) and Name(s)**	**Technology and Representational Tools Including Concrete Models by Competency**	**Course Description(s)**

varied representational tools, including concrete models:			
A.3.1 Core concepts and principles of Euclidean in two and three dimensions and two-dimensional non-Euclidean geometries	MATH 2221 – Foundations of Geometry MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry	Programs such as GeoGebra, Geometer's Sketchpad, NCTM Core Math Tools. Surfaces such as doughnuts, cones, hubcaps, Hershey's Kisses for creating and analyzing properties of geometric systems	MATH 1151 – Topics include: limits and continuity, finding limits and formal definitions of limits, one-sided and infinite limits, derivative, the derivative of a function and tangent lines, differentiation rules, rates of change, derivatives of trigonometric functions, differentiation of composite and implicit functions, differentiation of rational powers of functions, related rates, applications of derivative, extreme values of functions the Mean Value Theorem, the first derivative test, limits at infinity and asymptotes of a graph, optimization and differentials, integration, indefinite integrals and differential equations, integration by substitution, the definite integral, properties of definite integral, applications to area, the Fundamental Theorem of Calculus, substitution in definite integrals and numerical integration, inverse functions and
A.3.2 Transformations including dilations, translations, rotations, reflections, glide reflections; compositions of transformations; and the expression of symmetry in terms of transformations	MATH 2221 – Foundations of Geometry MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry MATH 2861 – Advanced Perspectives on High School Mathematics	Programs such as GeoGebra, Geometer's Sketchpad, NCTM Core Math Tools.	
A.3.3 Congruence, similarity and scaling, and their development and expression in terms of transformations	MATH 2221 – Foundations of Geometry MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry	Programs such as GeoGebra, Geometer's Sketchpad, NCTM Core Math Tools, iPads Apps, videos from Project Mathematics	
A.3.4 Right triangles and trigonometry	MATH 1151 - Calculus and Analytic Geometry I MATH 2221 – Foundations of Geometry MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry	Programs such as GeoGebra, Geometer's Sketchpad, NCTM Core Math Tools, Cut the Knot website	

	MATH 2861 – Advanced Perspectives on High School Mathematics		their derivatives, natural logarithm function, natural exponential functions, growth and decay, inverse trigonometric functions, hyperbolic functions, applications of integrals, areas between curves, volumes of solids of revolution, finding volumes by slicing, arc length, areas of surfaces of revolution and work, moments and centers of mass MATH 1152 – Topics include: techniques of integration (by parts, by trigonometric substitution, of powers of trigonometric functions, of rational functions by partial fractions, improper integrals), sequences and convergence of sequences, bounded sequences and monotonic sequences, infinite series of positive terms, alternating series and their convergence, absolute and conditional convergence of series, the integral test, root test, ratio test, introduction to power series, differentiation and integration of power series, Taylor's series, binomial series,
A.3.5 Application of periodic phenomena and trigonometric identities	MATH 1151 - Calculus and Analytic Geometry I MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry	Graphing calculators	
A.3.6 Identification, classification into categories, visualization, and representation of two- and three-dimensional objects (triangles, quadrilaterals, regular polygons, prisms, pyramids, cones, cylinders, and spheres)	MATH 2221 – Foundations of Geometry MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry	Programs such as GeoGebra, Geometer's Sketchpad, NCTM Core Math Tools, Concrete models of two- and three-dimensional objects and geoboards	
A.3.7 Formula rationale and derivation (perimeter, area, surface area, and volume) of two- and three-dimensional objects (triangles, quadrilaterals, regular polygons, rectangular prisms, pyramids, cones, cylinders, and spheres), with attention to units, unit comparison, and the iteration, additivity, and invariance related to measurements	MATH 1151 - Calculus and Analytic Geometry I MATH 1152 - Calculus and Analytic Geometry II MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry	Graphing calculators	
A.3.8 Geometric constructions, axiomatic reasoning, and proof	MATH 2221 – Foundations of Geometry MATH 2862 – Advanced Perspectives on Secondary Geometry and Trigonometry	Construction tools, Programs such as GeoGebra, Geometer's Sketchpad, NCTM Core Math Tools, Proof puzzles	
A.3.9 Analytic and coordinate geometry including algebraic proofs (e.g., the Pythagorean Theorem and its converse) and	MATH 1152 - Calculus and Analytic Geometry II	Surfaces such as doughnuts, cones, hubcaps, Hershey's Kisses	

equations of lines and planes, and expressing geometric properties of conic sections with equations	MATH 2221 – Foundations of Geometry	for creating and analyzing properties of geometric systems, Cut the Knot website	conic sections, quadratic equations, rotations, classifying conic sections by eccentricity, parametrizations of plane curves and calculus of parametrized curves, polar coordinates and graphing in polar coordinates, polar equations for conic sections, integration in polar coordinates, vectors in three dimensional space and solid geometry, vectors in the plane, vectors in space, dot products and cross products, lines and planes in space, cylinders and quadratic surfaces, cylindrical and spherical coordinates, vector-valued functions and space curves, unit tangent and unit normal vectors, arc length as the parameter for curves, curvature, torsion, TNB frame, plane motion MATH 2861 – Topics include: definition of functions, historical evolutions of functions, basic machinery of functions, properties of real functions, problems involving real functions, concept
A.3.10 Historical development and perspectives of geometry and trigonometry including contributions of significant figures and diverse cultures	MATH 4233 - Scientific, Historical, and Sociological Impact of Mathematics	A variety of internet sources, power point for student presentations, YouTube videos to illustrate concepts	

			of equation, algebraic structures and solving equations, the solving process, congruence, Euclid and congruence, the congruence transformations, symmetry, distance, similar figures, distances within figures, trigonometry, angle measure and the trigonometric ratios, the trigonometric functions and their connections, properties of the sine and cosine functions MATH 2221- Topics include: axioms and postulates in geometry, role of definitions, role of axioms, role of postulates, axioms of connection, axioms of betweeness, axioms of congruence, axioms of continuity, types and formats of proofs, validity of propositions in Euclid's Elements, equivalent and alternate forms of Euclid's fifth postulate, similarity, Euclidean results concerning circles, Euclidean results concerning triangles, constructions in Euclidean geometry, philosophy of construction, basic

			constructions in Euclidean geometry MATH 2862 – Topics include: direct proof, proof by contradiction, proof by counterexample, proof by induction, area of simple figures, the circle, areas of irregular shapes, volume, geometric transformations, functions, the matrix approach, transforming areas, transformations in three dimensions, laws of sine and cosine, similarity, Heron's Theorem, right triangle trigonometry, radian measure, graphing trigonometric curves, modeling with trigonometric functions, inverse trigonometric functions, trigonometric identities, vectors, introduction to non-Euclidean geometry, the Parallel Postulate, undefined terms MATH 4233 – Topics include: early numeration systems, Babylonian and Egyptian mathematics, Greek mathematician up to Euclid, Greek mathematicians beyond Euclid, Euclidean geometry, Chinese mathematics,

			Hindu mathematics, Arabian mathematics, European mathematics, modern mathematics

A.4. Statistics and Probability To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics related to statistics and probability with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models:	**Required Course Number(s) and Name(s)**	**Technology and Representational Tools Including Concrete Models by Competency**	**Course Description(s)**
A.4.1 Statistical variability and its sources and the role of randomness in statistical inference	MATH 4851 - Probability and Statistics for Middle/High School Mathematics	Tinkerplots software, Graphing calculators	MATH 4851 – Topics include: theoretical probability, empirical probability, simulation, fundamental elements of statistics, uses and misuses of statistics, designing and conducting surveys, sampling methods, organizing and representing data, histograms, frequency polygons, stem and leaf, box plots, scatter plots, frequency plots, univariate and bivariate data distributions, measures of central tendency, measures of dispersion, standard deviation, percentiles, standard scores, correlation, regression, curve fitting, basics of probability (experiment, outcome,
A.4.2 Creation and implementation of surveys and investigations using sampling methods and statistical designs, statistical inference (estimation of population parameters and hypotheses testing), justification of conclusions, and generalization of results	MATH 4851 - Probability and Statistics for Middle/High School Mathematics	Microsoft Excel, graphing calculators, power point for student presentations	
A.4.3 Univariate and bivariate data distributions for categorical data and for discrete and continuous random variables, including representations, construction and interpretation of graphical displays (e.g., box plots, histograms, cumulative frequency plots, scatter plots), summary measures, and comparisons of distributions	MATH 4851 - Probability and Statistics for Middle/High School Mathematics	Tinkerplots software, graphing calculators, Microsoft Excel, measurement tools	
A.4.4 Empirical and theoretical probability (discrete, continuous, and conditional) for both simple and compound events	MATH 4851 - Probability and Statistics for Middle/High School Mathematics	Concrete materials such as cubes, pennies, spinners, etc are used to investigate probability,	

		GeoGebra, NCTM Core Math Tools	sample space, event), counting techniques (permutation, combinations), rules of probability, conditional probability, independent events, Bayes theorem, tree diagram, contingency tables, probability distributions (binomial, normal, normal approximations), discrete random variables, probability distribution functions, continuous random variable, chi square distributions, sampling and sampling distributions, Central Limit theorem, estimation of population mean, confidence intervals, hypothesis testing MATH 4233 – Topics include: early numeration systems, Babylonian and Egyptian mathematics, Greek mathematician up to Euclid, Greek mathematicians beyond Euclid, Chinese mathematics, Hindu mathematics, Arabian mathematics, European mathematics, modern mathematics
A.4.5 Random (chance) phenomena, simulations, and probability distributions and their application as models of real phenomena and to decision making	MATH 4851 - Probability and Statistics for Middle/High School Mathematics	Graphing calculators, concrete models used in simulations, Minitab software	
A.4.6 Historical development and perspectives of statistics and probability including contributions of significant figures and diverse cultures	MATH 4233 - Scientific, Historical, and Sociological Impact of Mathematics	A variety of internet sources, power point for student presentations, YouTube videos to illustrate concepts	

A.5. Calculus To be prepared to develop student mathematical proficiency, all secondary mathematics teachers should know the following topics	**Required Course Number(s) and Name(s)**	**Technology and Representational Tools Including Concrete Models by Competency**	**Course Description(s)**

related to calculus with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models:			
A.5.1 Limits, continuity, rates of change, the Fundamental Theorem of Calculus, and the meanings and techniques of differentiation and integration	MATH 1151 – Calculus and Analytic Geometry I	Graphing calculators, Calculus in Motion software using Geometer's Sketchpad	MATH 1151 – Topics include: limits and continuity, finding limits and formal definitions of limits, one-sided and infinite limits, derivative, the derivative of a function and tangent lines, differentiation rules, rates of change, derivatives of trigonometric functions, differentiation of composite and implicit functions, differentiation of rational powers of functions, related rates, applications of derivative, extreme values of functions the Mean Value Theorem, the first derivative test, limits at infinity and asymptotes of a graph, optimization and differentials, integration, indefinite integrals and differential equations, integration by substitution, the definite integral, properties of definite integral, applications to area, the Fundamental Theorem of Calculus,
A.5.2 Parametric, polar, and vector functions	MATH 1152 – Calculus and Analytic Geometry II	Graphing calculators	
A.5.3 Sequences and series	MATH 1152 – Calculus and Analytic Geometry II	Graphing calculators	
A.5.4 Multivariate functions	MATH 1152 – Calculus and Analytic Geometry II	Graphing calculators	
A.5.5 Applications of function, geometry, and trigonometry concepts to solve problems involving calculus	MATH 1151 – Calculus and Analytic Geometry I MATH 1152 – Calculus and Analytic Geometry II MATH 2862 – Advance Perspectives on Secondary Geometry and Trigonometry	Graphing calculators, Calculus in Motion software using Geometer's Sketchpad	
A.5.6 Historical development and perspectives of calculus including contributions of significant figures and diverse cultures	MATH 4233 - Scientific, Historical, and Sociological Impact of Mathematics	A variety of internet sources, power point for student presentations, YouTube videos to illustrate concepts	

			substitution in definite integrals and numerical integration, inverse functions and their derivatives, natural logarithm function, natural exponential functions, growth and decay, inverse trigonometric functions, hyperbolic functions, applications of integrals, areas between curves, volumes of solids of revolution, finding volumes by slicing, arc length, areas of surfaces of revolution and work, moments and centers of mass MATH 1152 – Topics include: techniques of integration (by parts, by trigonometric substitution, of powers of trigonometric functions, of rational functions by partial fractions, improper integrals), sequences and convergence of sequences, bounded sequences and monotonic sequences, infinite series of positive terms, alternating series and their convergence, absolute and conditional convergence of series, the integral test, root test, ratio test, introduction to power

			series, differentiation and integration of power series, Taylor's series, binomial series, conic sections, quadratic equations, rotations, classifying conic sections by eccentricity, parametrizations of plane curves and calculus of parametrized curves, polar coordinates and graphing in polar coordinates, polar equations for conic sections, integration in polar coordinates, vectors in three dimensional space and solid geometry, vectors in the plane, vectors in space, dot products and cross products, lines and planes in space, cylinders and quadratic surfaces, cylindrical and spherical coordinates, vector-valued functions and space curves, unit tangent and unit normal vectors, arc length as the parameter for curves, curvature, torsion, TNB frame, plane motion MATH 4233 – Topics include: early numeration systems, Babylonian and Egyptian mathematics, Greek mathematician up to Euclid, Greek

			mathematicians beyond Euclid, Euclidean geometry, Chinese mathematics, Hindu mathematics, Arabian mathematics, European mathematics, modern mathematics MATH 2862 – Topics include: direct proof, proof by contradiction, proof by counterexample, proof by induction, area of simple figures, the circle, areas of irregular shapes, volume, geometric transformations, functions, the matrix approach, transforming areas, transformations in three dimensions, laws of sine and cosine, similarity, Heron's Theorem, right triangle trigonometry, radian measure, graphing trigonometric curves, modeling with trigonometric functions, inverse trigonometric functions, trigonometric identities, vectors, introduction to non-Euclidean geometry, the Parallel Postulate, undefined terms

A.6. Discrete Mathematics To be prepared to develop student mathematical proficiency, all secondary	**Required Course Number(s) and Name(s)**	**Technology and Representational Tools Including Concrete Models**	**Course Description(s)**

mathematics teachers should know the following topics related to discrete mathematics with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models:		**by Competency**	
A.6.1 Discrete structures including sets, relations, functions, graphs, trees, and networks	MATH 2410 - Discrete Mathematics	Microsoft Excel - spreadsheet	MATH 2410 – Topics include: basic concepts of logic, direct proofs, proofs by counterexample, proofs by contraposition, proofs by contradiction, constructive and nonconstructive proofs, mathematical induction, basic concepts of sets, set operations, Venn diagrams, containments and equality, mappings and their properties, cardinality and countability, Cartesian products and relations, division algorithm, Euclidean algorithm, modular arithmetic, pigeonhole principle, permutations, combinations, binomial theorem and Pascal's triangle, the principle of inclusion-exclusion, discrete probabilities, conditional probabilities, random variables and expectation, recurrence relations, generating functions, graphs,
A.6.2 Enumeration including permutations, combinations, iteration, recursion, and finite differences	MATH 2410 - Discrete Mathematics	Games and puzzles – Towers of Hanoi, Rubiks Cube, etc.	
A.6.3 Propositional and predicate logic	MATH 2410 - Discrete Mathematics	None used	
A.6.4 Applications of discrete structures such as modeling and solving linear programming problems and designing data structures	MATH 2410 - Discrete Mathematics	None used	
A.6.5 Historical development and perspectives of discrete mathematics including contributions of significant figures and diverse cultures	MATH 4233 - Scientific, Historical, and Sociological Impact of Mathematics	A variety of internet sources, power point for student presentations, YouTube videos to illustrate concepts	

			trees, Boolean algebra, applications of discrete mathematics MATH 4233 – Topics include: early numeration systems, Babylonian and Egyptian mathematics, Greek mathematician up to Euclid, Greek mathematicians beyond Euclid, Euclidean geometry, Chinese mathematics, Hindu mathematics, Arabian mathematics, European mathematics, modern mathematics

Part 3 – Institution Grading Policy From Undergraduate Catalog

Academic Standards

Grading System

Only grades A through F impact grade point average. The grading system used in evaluating a student's work is as follows:

A – Work of marked excellence

B – Work of superior quality

C – Work of average quality

D – Work of minimal passing quality

F – Failure to do work of passing quality

CR* – Credit for Official Certifications, Licenses, Diplomas, Military Credit, Validated Credit, and Work Experience (limited to 30 hours towards a degree)

LD** – Designates a Late Drop of a course (but not the entire semester schedule), granted for extenuating circumstances after the published last day to withdraw

LW** – Designates a Late Withdrawal of a complete semester's schedule, granted for extenuating circumstances after the published last day to withdraw

NC – No credit granted for course (audit)

NR – No grade reported by instructor

P – Work of passing quality in a-pass/fail course (limited to 9 hours towards a degree)

SC* – Credit by examination (AP/IB/CLEP), etc. (limited to 30 hours towards a degree)

U – Course not completed for justifiable reasons, students may not graduate with a U on their record

W** – Course dropped during withdrawal period

* CR and SC credits do not count towards residency hours or upper- level hours requirements. Up to 30 hours of each type, CR and SC, may be applied to a degree program.

** For more information about withdrawal grades, refer to the section *Changes in Schedules,* and either the Calendar in this catalog or the *Student Planner/Handbook.* Course withdrawal and refund dates can also be found in MyCentral in the Student Services tab in the UCM Registration section under the link Check Refund and Withdrawal Dates.

Grade Point Averages

In order to receive a degree, a student must earn a minimum grade point average of 2.00 (C) in each of the following areas:

1. All work attempted (cumulative GPA, includes transfer work)
2. All work attempted at Central Missouri (UCM GPA)
3. All work taken to satisfy major requirements at UCM
4. All work taken to satisfy minor requirements at UCM

Students must review their degree and major program for all minimum GPA requirements. Several degree programs specify grade standards that may apply to acceptance into a program and/or that must be maintained for graduation from a program. Such special standards are listed under the major programs in the curriculum section of this catalog.

Computation of Grade Point Average

In order to compute grade point average, total quality points earned are divided by total hours attempted. Each semester hour is assigned a grade point value as indicated below:

1. Each semester hour of A is assigned 4 quality points.
2. Each semester hour of B is assigned 3 quality points.
3. Each semester hour of C is assigned 2 quality points.
4. Each semester hour of D is assigned 1 quality point.
5. Each semester hour of F is assigned 0 quality points.
6. Each semester hour of CR, LD, LW, P, SC, or W is not considered.
7. Each semester hour of U and NR is not considered until a grade is assigned.

Academic Standing

Student academic standing is determined by both the cumulative GPA and the UCM GPA. Students can find their academic standing in MyCentral in the Student Services tab under "Check Your Registration Status" or "Unofficial Transcript".

Good Academic Standing

Central Missouri students who have both a 2.00 cumulative and UCM grade point average are in good academic standing and are eligible to enroll for classes.

Academic Probation

A student whose cumulative GPA or total UCM GPA drops below 2.00 will be placed on academic probation. New freshmen admitted to UCM as part of the Success Program are admitted on academic probation. A transfer student will be placed on academic probation at the time of admission if his/her cumulative GPA is less than 2.00. Students placed on academic probation may continue to enroll in classes. Students are encouraged to seek advice from their professional academic advisor about future enrollments. Students on academic probation may not enroll in more than 15 semester hours during any semester of academic probation.

Removal From Probation

A student placed on academic probation will continue on probation until the UCM GPA and the cumulative GPA are 2.00 or higher. When a student on academic probation raises their UCM GPA and their cumulative GPA to 2.00 or above, the student is removed from probation. Transfer credit may not be used to raise the UCM GPA.

Academic Suspension

A student on academic probation will be suspended from Central Missouri at the conclusion of his/her next semester/enrollment period if his/her semester/enrollment period GPA is less than 2.00. A transfer student who was admitted on probation will be suspended from Central Missouri at the conclusion of his/her first semester/ enrollment period if his/her semester/enrollment period GPA is less than 2.00. Academic suspension is for a period of one full semester (not including summer semester), after which students may petition for reinstatement. Reinstatement is not automatic nor guaranteed. International students must contact the International Center immediately upon suspension from the university.

Academic Dismissal

A student who has been suspended and later reinstated and continued on probation but does not achieve a semester GPA of 2.00 or higher in a subsequent semester/ enrollment period will be dismissed. Academic dismissal is for a period of one calendar year, after which a student may petition for reinstatement. Reinstatement is not automatic nor guaranteed. International students must contact the International Center immediately upon dismissal from the university.

Reinstatement. The reinstatement of students who have been suspended or dismissed from UCM is not automatic or guaranteed. Petitions for reinstatement are reviewed by the appropriate college or center based on the degree program a student has selected for reinstatement. Students in the Intensive English Program (IEP) who wish to petition for reinstatement must contact the English Language Center at **iep@ucmo.edu.**

The reinstatement petition can be accessed in MyCentral in the Student Services tab. For the best selection of courses, students should submit a petition in March for summer or fall semester reinstatement and in October for spring semester reinstatement. Petitions will be considered through the following deadlines:

Fall semester: July 15
Spring semester: November 15
Summer semester: April 15

The petition includes a written portion which should include an explanation of the circumstances that led to poor academic performance and an explanation of activities and plans which may lead to improved academic performance in the future. Other substantiating evidence may also be requested. No additional application fee is required. Students must submit transcripts from all colleges attended that are not already on file with UCM. Failure to disclose a transcript may result in dismissal from UCM. After a review of the petition, academic records, and any other substantive evidence available, students will be notified of the reinstatement decision. Some colleges may require students to meet personally with a reinstatement review board.

Students may petition for reinstatement as follows:

1. Students who have been suspended may petition for reinstatement after sitting out one fall or spring semester (Summer Session does not count as a semester for suspension purposes). Students who have been dismissed may petition for reinstatement after one calendar year.
2. A student with documented extenuating circumstances who has been suspended or dismissed may petition for immediate (or early) reinstatement. Petitions for early reinstatement may not be submitted via MyCentral. Students seeking this should contact the dean of their college directly for consideration. Early reinstatement is rarely granted and only applies for extenuating circumstances for which supporting evidence can be provided.

Dean's List

To be eligible for the Dean's List, a student must be an undergraduate who earns 12 or more semester hours of residence credit during the fall or spring semesters with a grade point average for the semester of 3.50 or above. During the summer semester a student must be enrolled in nine or more semester hours and achieve a 3.50 or above grade point average.

Graduation with Honors

To be eligible for graduation with honors, a student must have earned both cumulative and Central Missouri grade point averages of 3.50. Those with cumulative and Central Missouri grade point averages of 3.50 to 3.74 graduate Cum Laude; 3.75 to 3.84, Magna Cum Laude; and 3.85 and above, Summa Cum Laude. Should the Central Missouri and cumulative GPAs be in different categories, the lower designation of honors will be recognized.

Grade Appeals

Students appealing a grade have one calendar year from the time the grade was issued to appeal any grade changes. These appeals should be directed to the instructor who taught the course in question. Please refer to the current *Grade Appeal Procedure* in the UCM *Student Planner/Handbook* for information regarding this procedure.

Grade Requirements for Program Admission and Graduation

In addition to the general requirements applicable to all areas, several academic programs specify grade standards that may apply to program admission and/or graduation from a program. Such special standards are listed under the major programs in the curriculum section of this catalog.

Unfinished Work

An instructor may report a semester grade of U when, for justifiable reasons, the student has not completed the work of the course. For example, if a student has an illness or death in the family during the last week of the course, an extension may be granted at the discretion of the instructor. At the end of the next semester (Fall, Spring or Summer) the U becomes an F unless the course requirements have been satisfactorily completed or the course is of an individualized nature, e.g., thesis, research report, or similar investigation. Students do not enroll in the class during the subsequent semester. Students having more than one U grade are expected to reduce their course load accordingly in order to complete the unfinished work. It is the student's responsibility to contact his/her instructor concerning the removal of the U grade. Students may not graduate with a U grade on their record. If the work is unable to be completed or the student does not wish to complete the work (in the case of an elective course), the grade will be changed to an F to meet graduation requirements.

Part 4 – Data Tables

Data Table A

Grades* in Required Mathematics and/or Mathematics Education Courses
Secondary Mathematics Education
Undergraduate Program Completers

*A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0

Course Number and Name	2010 - 2011			2011 - 2012			2012 - 2013		
	Mean Course Grade* and Range	Number of Completers	% of Completers Meeting Minimum Expectation (C or better)	Mean Course Grade* and Range	Number of Completers	% of Completers Meeting Minimum Expectation (C or better)	Mean Course Grade* and Range	Number of Completers	% of Completers Meeting Minimum Expectation (C or better)
Math 1151 Calculus and Analytic Geometry I	3.14 (2.0 – 4.0)	7	100%	3.4 (2.0 – 4.0)	5	100%	3.2 (2.0 – 4.0)	10	100%
Math 1152 Calculus and Analytic Geometry II	3.42 (2.0 – 4.0)	7	100%	2.8 (2.0 – 3.0)	5	100%	3.3 (2.0 – 4.0)	10	100%
Math 2221 Foundations of Geometry	3.0 (2.0 – 4.0)	7	100%	3.2 (3.0 – 4.0)	5	100%	3.1 (2.0 – 4.0)	10	100%
Math 2410 Discrete Mathematics	3.29 (2.0 – 4.0)	7	100%	3.0 (2.0 – 4.0)	5	100%	2.8 (2.0 - 4.0)	10	100%
Math 3710 Linear Algebra	3.14 (2.0 – 4.0)	7	100%	3.2 (2.0 – 4.0)	5	100%	3.0 (2.0 - 4.0)	10	100%
Math 4710 Algebraic Structures	2.71 (2.0 – 4.0)	7	100%	2.6 (2.0 – 3.0)	5	100%	2.5 (2.0 - 4.0)	10	100%
Math 4851 Probability and Statistics	3.43 (2.0 – 4.0)	7	100%	3.8 (3.0- 4.0)	5	100%	3.8 (2.0 - 4.0)	10	100%
Math 2861 Advanced Perspectives on High School Mathematics	Not Required during this academic year.			3.33 (2.0 – 4.0)	5	100%	3.3 (2.0 – 4.0)	10	100%
ICAP 4233 he Scientific, Historical, and Sociological Impact of Mathematics	3.29 (2.0 – 4.0)	7	100%	4.0 (4.0)	5	100%	3.3 (3.0 - 4.0)	10	100%

Data Table B

Mean GPA* in Required Mathematics Major Courses for Secondary Mathematics Education Completers Baccalaureate Program *A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0			
Academic Year	**Mean GPA* and Range**	**Number of Completers**	**% of Completers Meeting Minimum Expectation**
2010 – 2011	3.22 (2.32 – 4.0)	[redacted]	100%
2011 – 2012	3.22 (2.93 – 3.65)	[redacted]	100%
2012 – 2013	3.18 (2.10 – 4.0)	[redacted]	100%