Section IV Evidence for Meeting Standards
#2 MAT Course Grades

1. Description of Course Grades in major courses

In the MAT program, candidates must complete 15 semester hours in mathematics, including 12 hours at the 500-level, and must choose three of the five core courses. Course grade information is included for the core courses: Real Analysis (MATH 512), Complex Variables (MATH 515), Algebraic Structures (MATH 532), Set Theory (MATH 519) and Proof (MATH 551).

To complete their mathematics credits, candidates choose from among offerings at the 500-level and may include up to 3 credits of coursework at the 400-level. MAT candidates who lack mathematics courses required in the undergraduate program may include one such 400-level course on their Plan of study.

2. Alignment of Courses with NCTM Standards and Indicators

Alignment of Courses Content with NCTM Standards and Indicators	
MATH 512: Foundations of Higher Analysis	1.1, 1.2, 3.1, 3.2, 3.3, 4.1, 4.3, 5.1, 5.2, 5.3, 6.1, 10.1, 10.4, 10.5, 12.1, 12.2, 12.3, 12.4, 12.5
MATH 515: Introduction to Complex Variables	1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1, 4.3, 5.1, 5.2, 5.3, 6.1, 9.1, 9.2, 9.7, 9.8, 9.9, 10.1, 10.4, 10.5, 12.1, 12.2, 12.3, 12.4, 12.5
MATH 532: Algebraic Structures	1.1, 1.2, 2.3, 2.4, 3.1, 3.2, 3.3, 4.1, 4.3, 5.1, 5.2, 5.3, 6.1, 9.1, 9.7, 9.9, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 13.1, 13.2, 13.3
MATH 519: Set Theory	1.3, 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.3, 4.1, 4.2, 6.1, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8
MATH 551: Topics in Proof	2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.3, 9.5, 9.7

3. Data Results

Every candidate who enters the program is required to have a 3.0 GPA overall and in mathematics courses. In addition, they must submit scores of 140 or higher on the ETS PRAXIS II Math #0061 as evidence of previous knowledge in mathematics in order to be admitted to the program. While in the program, candidates are required to maintain a 3.0 GPA in all graduate level courses required for graduation. Grades below B in courses listed on their Plan of Study and required for graduation are not considered to be of graduate quality and students who earn them must meet with their advisors. They must maintain a GPA of 2.5 in any undergraduate mathematics course that is taken to remediate deficiencies and satisfy requirements of the secondary education – mathematics program. All four MAT graduates in the last three years have met the requirements.

4. Data Interpretation

Candidates in any graduate program are expected to maintain a GPA of 3.0. Grades below B are not considered of graduate quality. A grade of C requires consultation with the faculty advisor; a second grade of C is cause for dismissal. Grades below C are unacceptable.

Faculty who teach common courses use a collaboratively-developed grading rubric. Since course grades are based on multiple assessments during the course, their average provides a reliable indication of the candidate's knowledge of mathematics. The breadth of Indicators from the NCTM Standards contained in these core courses and the previously examined background (admission criteria to the program) provides evidence of their preparedness to teach secondary level mathematics.

5. Assessment Documentation for Course Grades

a. Course Descriptions for the required courses are presented:

Master's Level Courses – all candidates choose 3 from the following 5 courses

MATH 512: Foundations of Higher Analysis 3 credit hours
Fundamental concepts in the theory of calculus are presented. Topics include limits, continuity and uniform continuity, differentiation, the Riemann integral, sequences and series, and convergence criteria.

MATH 515: Introduction to Complex Variables 3 credit hours
Techniques and concepts of the algebra and calculus of functions of one complex variable are studied, including trigonometric, exponential, and logarithmic functions.

MATH 519: Set Theory 3 credit hours
The foundations of set theory and logic are studied in the context of their application in the construction of number systems, from the natural numbers through the reals.

MATH 532: Algebraic Structures 3 credit hours
Selected topics in the development of groups, rings, modules, and fields are covered, including homomorphisms, permutation groups, basic Galois Theory, ring extension problems, and ideals.

MATH 551: Topics in Proof 3 credit hours
Varying topics in mathematical proof are examined, from number systems and functions to abstract spaces.

b. Scoring Guide for Course Grades

Graduate Courses Scoring Guide

The College uses grades A, A-, B+, …, D-, and F with conversions to grade points on a 4.0 G.P.A. system. The established College guidelines for grade interpretation are:

A Excellent

B Good
C Not graduate quality
D Not graduate quality
F Failure

Faculty in the Mathematics and Computer Science Department who teach required courses have collaboratively defined the meaning of grades for specific courses. They appear below.

Foundations of Higher Analysis (MATH 512)

4.0 Student demonstrates an excellent command of the skills, procedures, and concepts of the course evidenced by:

- Excellent conceptual understanding of sequences and series of real numbers.
- Excellent conceptual understanding of functions of real numbers, limits and continuity, differentiability, and role of the derivative.
- Excellent conceptual understanding of Riemann integrals and the Fundamental Theorem of calculus.
- Excellent conceptual understanding of sequences and series of functions.
- Excellent ability to consistently write clear, correct proofs, including the use of a variety of proof-making techniques and the use of counterexamples.

3.0 Student demonstrates a good command of the skills, procedures, and concepts of the course evidenced by:

- Good conceptual understanding of sequences and series of real numbers.
- Good conceptual understanding of functions of real numbers, limits and continuity, differentiability, and role of the derivative.
- Good conceptual understanding of Riemann integrals and the Fundamental Theorem of calculus.
- Good conceptual understanding of sequences and series of functions.
- Good ability to write correct proofs throughout the course, including the use of a variety of proof-making techniques and the use of counterexamples.

2.0 Student demonstrates a fair command of the skills, procedures, and concepts of the course evidenced by:

- Fair conceptual understanding of sequences and series of real numbers.
- Fair conceptual understanding of functions of real numbers, limits and continuity, differentiability, and role of the derivative.
- Fair conceptual understanding of Riemann integrals and the Fundamental Theorem of calculus.
- Fair conceptual understanding of sequences and series of functions.
- Fair ability to write correct proofs throughout the course, including some use of counterexamples.

1.0 Student demonstrates a poor command of the skills, procedures, and concepts of the course evidenced by:

- Poor conceptual understanding of sequences and series of real numbers.

- Poor conceptual understanding of functions of real numbers, limits and continuity, differentiability, and role of the derivative.
- Poor conceptual understanding of Riemann integrals and the Fundamental Theorem of calculus.
- Poor conceptual understanding of sequences and series of functions.
- Poor ability to write correct proofs throughout the course.

0.0 Student demonstrates no command of the skills, procedures, and concepts of the course evidenced by:

- Unacceptable conceptual understanding of sequences and series of real numbers.
- Unacceptable conceptual understanding of functions of real numbers, limits and continuity, differentiability, and role of the derivative.
- Unacceptable conceptual understanding of Riemann integrals and the Fundamental Theorem of calculus.
- Unacceptable conceptual understanding of sequences and series of functions.
- Unacceptable ability to write proofs.
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Introduction to Complex Variables (MATH 515)

4.0 Student demonstrates an excellent command of the skills, procedures, and concepts of the course evidenced by:

- Excellent understanding of the algebra and geometry of complex numbers, both in rectangular and polar form.
- Excellent understanding of the mapping properties of the elementary complex functions.
- Excellent understanding of the concept of analytic function and related theorems, and always knows when and how to apply them to solve problems.
- Excellent understanding of the Theory of Complex Integration, Taylor and Laurent series, and the Theory of Residues, and always knows when and how to apply the relevant theorems and formulas to solve problems.

3.0 Student demonstrates a good command of the skills, procedures, and concepts of the course evidenced by:

- Good understanding of the algebra and geometry of complex numbers, both in rectangular and polar form.
- Good understanding of the mapping properties of the elementary complex functions.
- Good understanding of the concept of analytic function and related theorems, and generally applies them correctly to solve problems.
- Good understanding of the Theory of Complex Integration, Taylor and Laurent series, and the Theory of Residues, and generally applies the relevant theorems and formulas correctly to solve problems.

2.0 Student demonstrates a fair command of the skills, procedures, and concepts of the course evidenced by:

- Fair understanding of the algebra and geometry of complex numbers, both in rectangular and polar form.
- Fair understanding of the mapping properties of the elementary complex functions.

- Fair understanding of the concept of analytic function and related theorems; sometimes has difficulty applying them to solve problems.
- Fair understanding of the Theory of Complex Integration, Taylor and Laurent series, and the Theory of Residues; sometimes has difficulty applying the relevant theorems and formulas to solve problems.

1.0 Student demonstrates a poor command of the skills, procedures, and concepts of the course evidenced by:

- Poor understanding of the algebra and geometry of complex numbers; frequently makes computational mistakes.
- Poor understanding of the mapping properties of the elementary complex functions.
- Poor understanding of the concept of analytic function and related theorems, rarely uses them correctly to solve problems.
- Poor understanding of the Theory of Complex Integration, Taylor and Laurent series, and the Theory of Residues; rarely uses the relevant theorems and formulas correctly.

0.0 Student demonstrates no command of the skills, procedures, and concepts of the course evidenced by:

- Unacceptable understanding of the algebra and geometry of complex numbers, and of the mapping properties of the elementary complex functions.
- Unacceptable understanding of the concept of analytic function and related theorems.
- Unacceptable understanding of the Theory of Complex Integration, Taylor and Laurent series, and the Theory of Residues.
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Set Theory (MATH 519)

4.0 Student demonstrates an excellent command of the skills, procedures, and concepts of the course evidenced by:

- Excellent conceptual understanding of basic set concepts, including: the empty set, pair sets vs. ordered pairs, finite and infinite unions and intersections, Cartesian products, orderings, equivalence classes, injections, surjections, bijections, finite vs. infinite sets, equinumerosity and non-equinumerosity among infinite sets.
- Excellent ability to apply theorems and definitions correctly.
- Excellent understanding of basic proof and disproof techniques.
- Excellent ability to write a complete, clear, correct proof of a theorem.
- Excellent understanding of the fundamental definitions of set theory and how to use them correctly.
- Excellent ability to correctly construct arithmetic systems from the natural numbers to the integers to the rationals to the real number system.
- Excellent appreciation of the Zermelo-Fraenkel axioms and the continuum hypothesis.
- Excellent ability to state the axiom of choice.

3.0 Student demonstrates a good command of the skills, procedures, and concepts of the course evidenced by:

- Good conceptual understanding of basic set concepts, including: the empty set, pair sets vs. ordered pairs, finite and infinite unions and intersections, Cartesian products,

orderings, equivalence classes, injections, surjections, bijections, finite vs. infinite sets, equinumerosity and non-equinumerosity among infinite sets.
- Good ability to apply theorems and definitions correctly.
- Good understanding of basic proof and disproof techniques.
- Good ability to write a proof correctly, perhaps with some steps missing.
- Good understanding of the fundamental definitions of set theory and how to use them correctly.
- Good appreciation of a way to define arithmetic systems from the natural numbers to the integers to the rationals to the real number system.
- Good appreciation of the Zermelo-Fraenkel axioms and the continuum hypothesis.

2.0 Student demonstrates a fair command of the skills, procedures, and concepts of the course evidenced by:

- Fair conceptual understanding of basic set concepts, including: the empty set, pair sets vs. ordered pairs, finite and infinite unions and intersections, Cartesian products, orderings, equivalence classes, injections, surjections, bijections, finite vs. infinite sets, equinumerosity and non-equinumerosity among infinite sets.
- Fair ability to apply theorems and definitions correctly.
- Fair understanding of basic proof and disproof techniques.
- Fair ability to write a proof correctly; sometimes steps are missing or the logic is confused.
- Fair understanding of the fundamental definitions of set theory and how to use them correctly.
- Fair appreciation of a way to define arithmetic systems from the natural numbers to the integers to the rationals to the real number system, but with gaps or flaws.
- Fair appreciation of the Zermelo-Fraenkel axioms and the continuum hypothesis.

1.0 Student demonstrates a poor command of the skills, procedures, and concepts of the course evidenced by:

- Poor conceptual understanding of basic set concepts, including: the empty set, pair sets vs. ordered pairs, finite and infinite unions and intersections, Cartesian products, orderings, equivalence classes, injections, surjections, bijections, finite vs. infinite sets, equinumerosity and non-equinumerosity among infinite sets.
- Poor ability to apply theorems and definitions correctly.
- Poor understanding of basic proof and disproof techniques.
- Poor ability to write a proof correctly; usually steps are missing or the logic is confused.
- Poor understanding of fundamental definitions of set theory.

0.0 Student demonstrates no command of the skills, procedures, and concepts of the course evidenced by:

- Unacceptable conceptual understanding of basic set concepts, including: the empty set, pair sets vs. ordered pairs, finite and infinite unions and intersections, Cartesian products, orderings, equivalence classes, injections, surjections, bijections, finite vs. infinite sets, equinumerosity and non-equinumerosity among infinite sets.
- Unacceptable ability to apply a theorem or definition correctly.
- Unacceptable understanding of basic proof and disproof techniques.

- Unacceptable ability to write a correct proof.
- Unacceptable understanding of the fundamental definitions of set theory.

Algebraic Structures (MATH 532)

4.0 Student demonstrates an excellent command of the skills, procedures, and concepts of the course evidenced by:

- Excellent conceptual understanding of the deeper ideas of group, ring, field, homomorphism and cosets, including subgroups and subrings, ideals, quotient groups and rings, including polynomial rings and extension fields .
- Excellent understanding of the definitions relating to algebraic structures and how to use them correctly.
- Excellent ability to apply a theorem correctly.
- Excellent ability to write a complete, clear, correct proof of a theorem.
- Excellent grasp of basic proof and disproof techniques.

3.0 Student demonstrates a good command of the skills, procedures, and concepts of the course evidenced by:

- Good conceptual understanding of the deeper ideas of group, ring , field, homomorphism and cosets, including subgroups and subrings, ideals, quotient groups and rings, including polynomial rings and extension fields.
- Good understanding of the definitions relating to algebraic structures and how to use them.
- Good ability to apply a theorem correctly.
- Good ability to write a proof with possibly some steps missing.
- Good grasp of basic proof and disproof techniques.

2.0 Student demonstrates a fair command of the skills, procedures, and concepts of the course evidenced by:

- Fair conceptual understanding of the deeper ideas of group, ring, field, homomorphism and cosets, including subgroups and subrings, ideals, quotient groups and rings, including polynomial rings and extension fields.
- Fair understanding of the definitions relating to algebraic structures and how to use them.
- Fair ability to apply a theorem correctly.
- Fair ability to write a proof correctly; sometimes steps are missing or the logic confused.
- Fair grasp of basic proof and disproof techniques.

1.0 Student demonstrates a poor command of the skills, procedures, and concepts of the course evidenced by:

- Poor conceptual understanding of the deeper ideas of group, ring, field, homomorphism and cosets, including subgroups and subrings, ideals, quotient groups and rings, including polynomial rings and extension fields.
- Poor understanding of the definitions relating to algebraic structures and their use.

- Poor ability to apply a theorem correctly.
- Poor ability to write a proof correctly; frequently steps are missing or the logic is confused.
- Poor grasp of basic proof and disproof techniques.

0.0 Student demonstrates no command of the skills, procedures, and concepts of the course evidenced by:

- Unacceptable conceptual understanding of the deeper ideas of group, ring , field, homomorphism and cosets, including subgroups and subrings, ideals, quotient groups and rings, including polynomial rings and extension fields.
- Unacceptable understanding of the definitions relating to algebraic structures and their use.
- Unacceptable ability to apply a theorem correctly.
- Unacceptable ability to write a proof correctly; proofs are usually substantially incorrect.
- Unacceptable grasp of basic proof and disproof techniques.

Topics in Proof (MATH 551)

4.0 Student demonstrates an excellent command of the skills, procedures, and concepts of the course evidenced by:

- Excellent ability to write proofs. Proofs are complete and correct.
- Excellent understanding of definitions and always uses them correctly.
- Excellent grasp of basic proof techniques.
- Excellent knowledge of symbolic logic and its use.

3.0 Student demonstrates a good command of the skills, procedures, and concepts of the course evidenced by:

- Good ability to write proofs. Proofs are mostly correct and occasionally missing some steps.
- Good understanding of definitions and normally uses them correctly.
- Good grasp of basic proof techniques.
- Good knowledge of symbolic logic and its use.

2.0 Student demonstrates a fair command of the skills, procedures, and concepts of the course evidenced by:

- Fair ability to write proofs. Proofs are started but sometimes steps are missing or the logic is flawed.
- Fair understanding of definitions and often uses them correctly.
- Fair grasp of basic proof techniques.
- Fair knowledge of symbolic logic and its use.

1.0 Student demonstrates a poor command of the skills, procedures, and concepts of the course evidenced by:

- Poor ability to write proofs. Proofs often are started incorrectly or the most appropriate method of proof is not selected. Normally steps are missing and the logic is flawed.

- Poor understanding of definitions and often are used incorrectly.
- Poor grasp of proof techniques.
- Poor knowledge of symbolic logic and its use.

c. Data for M.A.T. Completers from Course Grades

For each of the four M.A.T. candidates course grades were entered to determine distribution and average grade in each required course. In addition, the G.P.A. in these courses was computed for each candidate. All courses were completed at the College.

Grades in Five Graduate Mathematics Courses – Completers							
2007-2008 through 2009-2010 (n = 4)							
Course/Grade	A	B	C	D	F	Mean (n)*	Range
MATH 512	2	1	1			3.415 (4)	2.33 – 4.0
MATH 515	4					3.915 (4)	3.67 – 4.0
MATH 519		2				3.33 (2)	3.33
MATH 532	2		1			3.22 (3)	2.33 – 3.67
MATH 551	3	1				3.50 (2)	3.0 – 3.67
	*One candidate took all five courses.						

Candidate's G.P.A. in Graduate Mathematics Courses – Completers Minimum Mathematics G.P.A. to Complete the Program is 3.0 2007-2008 through 2009-2010 (n = 4)					
	Candidate 1	Candidate 2	Candidate 3	Candidate 4	Pass Rate
GPA courses listed above	3.17	3.59	3.583	3.466	100%