

Modification to Mathematics Requirements of the BSc in Mathematics Education

Department of Mathematics
New York City College of Technology
City University of New York

March 22, 2022

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Curriculum Modification Proposal Form

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| Title of Proposal | Modification to Mathematics Requirements of the BSc in Mathematics Education |
| Date | March 22, 2022 |
| Major or Minor | Minor |
| Proposer's Name | Andrew Douglas and Nadia Kennedy |
| Department | Mathematics |
| Date of Departmental Meeting in which proposal was approved | 04-07-22 |
| Department Chair Name | Jonathan Natov |
| Department Chair Signature and Date | <i>Jonathan Natov</i> 04-07-22 |
| Academic Dean Name | Justin Vazquez-Poritz |
| Academic Dean Signature and Date | 9/2/22 |
| Brief Description of Proposal | We propose to modify the mathematics requirements in the BSc in Mathematics Education. Under the proposal, two required mathematics courses are removed (<i>MAT3075 Real Analysis</i> and <i>MAT4030 History of Mathematics</i>), and one elective mathematics course is added. The two removed courses are included in the list of courses that may be chosen as the mathematics elective in the proposed curriculum. |
| Brief Rationale for Proposal | <p>This minor curriculum proposal is, in part, a response to new NCTM Standards for Secondary Mathematics Teacher Preparation Programs published in 2020. These standards no longer require knowledge of the historical development of mathematical concepts. Hence, one of the two mathematics courses that we propose to remove is <i>MAT4030 History of Mathematics</i>. Although, students may still take this course as a mathematics elective in the proposed curriculum.</p> <p>The proposed changes in mathematics requirements also better support mathematics education students' timely completion of program requirements, and facilitates a smoother transfer of students into the mathematics education program. Finally, the changes sharpen the program's focus on the development of the fundamentals necessary for success as a mathematics educator-mastering the mathematics taught in the middle and high school classroom, and gaining proficiency in mathematics pedagogy and practice.</p> |

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|-------------------------|--|
| Proposal History | <ul style="list-style-type: none"> • Proposal passed the Mathematics Education Committee on March 17, 2022 • Proposal passed the Mathematics Department Curriculum Committee on... • Proposal passed the Mathematics Department on... |
|-------------------------|--|

ALL PROPOSAL CHECK LIST

| | |
|---|----|
| Completed CURRICULUM MODIFICATION FORM including: | |
| • Brief description of proposal | X |
| • Rationale for proposal | X |
| • Date of department meeting approving the modification | X |
| • Chair's Signature | X |
| • Dean's Signature | X |
| Evidence of consultation with affected departments List of the programs that use this course as required or elective, and courses that use this as a prerequisite. | NA |
| Documentation of Advisory Commission views (if applicable). | NA |
| Completed <u>Chancellor's Report Form</u> . | X |

EXISTING PROGRAM MODIFICATION PROPOSALS

| | |
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| Documentation indicating core curriculum requirements have been met for new programs/options or program changes. | NA |
| Detailed rationale for each modification (this includes minor modifications) | X |

Description of Modifications to Mathematics Requirements

We propose to modify the mathematics requirements in the BSc in Mathematics Education. Under the proposal, two required mathematics courses are removed (*MAT3075 Real Analysis* and *MAT4030 History of Mathematics*), and one elective mathematics course is added. The two removed courses are included in the list of courses that may be chosen as the mathematics elective in the proposed curriculum. The table below describes the proposed modifications.

| Current Required Mathematics Courses in the BSc in Mathematics Education | Proposed Required Mathematics Courses in the BSc in Mathematics Education |
|--|--|
| MAT1372 Statistics with Probability 3 cr | MAT1372 Statistics with Probability 3 cr |
| MAT1475 Calculus I 4 cr | MAT1475 Calculus I 4 cr |
| MAT1575 Calculus II 4 cr | MAT1575 Calculus II 4 cr |
| MAT2571 Introduction to Proofs and Logic 4 cr | MAT2571 Introduction to Proofs and Logic 4 cr |
| MAT2580 Introduction to Linear Algebra 3 cr | MAT2580 Introduction to Linear Algebra 3 cr |
| MAT2675 Calculus III 4 cr | MAT2675 Calculus III 4 cr |
| MAT3050 Geometry 4 cr | MAT3050 Geometry 4 cr |
| MAT3075 Real Analysis 4 cr | MAT3080 Modern Algebra 4 cr |
| MAT3080 Modern Algebra 4 cr | MEDU3000 Mathematics of the Secondary School Curriculum 4 cr |
| MAT4030 History of Mathematics 3 cr | |
| MEDU3000 Mathematics of the Secondary School Curriculum 4 cr | <u>Take one of the following courses: MAT2440, MAT2680, MAT3075, MAT4030 3 to 4 cr</u> |
| Total Credits = 41 | <u>Total Credits = 37 to 38</u> |

The proposed changes reduce the number of required mathematics credits, which we propose to add to the Free Elective component of the program:

| Current Free Elective Courses | Proposed Free Elective Courses |
|---|--|
| Take additional credits, if necessary, to make 120 credits | <u>Take up to 10 credits to make 120 credits</u> |

Rationale for Modifications to Mathematics Requirements

This minor curriculum proposal is, in part, a response to new mathematics standards of the National Council of Teachers of Mathematics (NCTM) for Secondary Mathematics Teacher Preparation Programs published in 2020. These standards must be met for our mathematics education program to be accredited with the Association for Advancing Quality in Educator Preparation (AAQEP).

NCTM's new mathematics standards no longer require knowledge of the historical development of mathematical concepts. Hence, one of the two mathematics courses that we propose to remove is *MAT4030 History of Mathematics*. Although, students may still take this course as a mathematics elective in the proposed curriculum.

The proposed changes in mathematics requirements also better support mathematics education students' timely completion of program requirements, and facilitates a smoother transfer of students into the mathematics education program. Finally, the changes sharpen the program's focus on the development of the fundamentals necessary for success as a mathematics educator-mastering the mathematics taught in the middle and high school classroom, and gaining proficiency in mathematics pedagogy and practice.

Supporting students' timely completion of program requirements

The proposed curriculum change would create greater overlap between required mathematics courses and high-enrollment, multi-section mathematics courses currently offered by the Mathematics Department. The proposal would lower the required mathematics credits, that are only taken by mathematics education students, from 23 credits to 16 credits.

Creating this greater overlap addresses two issues faced by the mathematics education program. First, the program currently has low enrollment-as of March 16, 2022 there were 14 students. This results in core mathematics classes being cancelled and not being offered every academic year. This in turn causes significant disruption in students' graduation timelines. Greater overlap would allow for fewer classes to be cancelled, and students to progress more quickly towards completing program requirements.

Second, the student field experience and student teaching school placement requirements in the program are very high- NYS requires at least 100 hours of school field experience and 14 weeks of full-time student teaching in the last semester of study. As a result, scheduling classes to accommodate the placements of all students is difficult. This leads to some students needing to postpone required courses, further disrupting their graduation timelines. Creating greater course overlap addresses this problem by increasing scheduling flexibility. This second point is an issue regardless of the program's enrollment size, and is addressed by the curriculum proposal.

Facilitating the transfer of students into the program

Creating greater overlap with existing mathematics courses will make transferring into the program easier-with the proposed curriculum, a transferring student may lose fewer classes

upon transfer, and have fewer classes to complete. This will make transferring into the program more appealing, and hence contribute to the program's enrollment.

Focusing on the fundamentals of mathematics education

The proposal will sharpen the program's focus on the fundamentals of mathematics education—mastering the mathematics taught in the middle and high school classroom, and gaining proficiency in mathematics pedagogy and practice. At present, the program's curriculum has the additional goal of preparing students for graduate work in pure mathematics. The inclusion of *MAT3075 Introduction to Real Analysis* in the current curriculum supports this additional goal. Under the proposed curriculum, this course would not be required, but students would still have the option to complete it as electives. Students who are interested in pursuing graduate work in pure mathematics would be advised to take this course.

The current curriculum of the mathematics education program is very heavy. Students need to complete requirements roughly equivalent to those of a bachelor's degree in pure mathematics; a large pedagogy component (45 credits); extensive student teaching and observation placements (14 weeks full-time); and pass state licensure exams. The requirements of the program can be overwhelming.

To complete the current mathematics requirements, students need to progress quickly through foundational mathematics courses (e.g., *MAT1475 Calculus I*, *MAT1575 Calculus II*, and *MAT2580 Linear Algebra*), after which they take advanced pure mathematics courses (e.g., *MAT3075*). All mathematics courses should be completed before their last semester, during which student teaching placements are scheduled.

Under this heavy, condensed, and advanced schedule of mathematics courses, students are not always able to master even the foundational mathematics courses. This is evidenced by the results of the Content Specialty Test (CST) in mathematics—one of the state licensure exams. For instance, in 2017, only 3 of 6 of our students passed the CST.

It should be noted that the CST is almost entirely at the level of *MAT1375 Precalculus* and below. And, it includes no content above *MAT1475 Calculus I*. The proposed curriculum allows students to spread out the mathematics requirements less densely across four years, allowing them more time to focus on mastering the fundamental mathematics required on the CST.

Not only does the proposed curriculum prepare students well for the CST, it also meets or exceeds the 2020 mathematics standards set by the NCTM for initial teacher preparation programs. In a following section, we provide evidence that the NCTM standards are met by the proposed curriculum.

Change in mathematics standards for teacher preparation programs

In 2020, the NCTM changed their mathematics standards for Secondary Mathematics Teacher Preparation Programs. The standards no longer require knowledge of the historical development of mathematical concepts. In line with these changes to mathematics standards, we propose to remove *MAT4030 History of Mathematics* as a required course, but we do include it as a mathematics elective.

Neither the old 2012 nor the new 2020 NCTM standards mandated a course in real analysis. *MAT3075 Intro. to Real Analysis* was not, and is not mandatory for Secondary Mathematics Teacher Preparation Programs. This course served to aid in preparing students for graduate work in pure mathematics. It also provided additional evidence for having met the Calculus component of NCTM's Mathematics Standards, but was not required to meet this component. The Calculus component is ostensibly unchanged from 2012 to 2020, with the exception of the removal of the historical development of Calculus in 2020.

Proposed Sequence of Courses by Semester

| Semester 1 (13 to 15 credits) | | | Semester 2 (16 credits) | | |
|-------------------------------|--------------------------------|-----------|-------------------------|----------------------------------|------|
| ENG1101 | English Composition I | 3 cr | ENG1121 | English Composition II | 3 cr |
| LPS | Life and Physical Sciences | 3 to 5 cr | MAT1575 | Calculus II | 4 cr |
| MAT1475 | Calculus I | 4 cr | MAT2580 | Linear Algebra | 3 cr |
| USED | US Experience in its Diversity | 3 cr | PSY1101 | Intro. to Psychology | 3 cr |
| | | | WCGI | World Cultures and Global Issues | 3 cr |

| Semester 3 (16 credits) | | | Semester 4 (14 credits) | | |
|-------------------------|--------------------------------------|------|-------------------------|--|------|
| MAT1372 | Statistics with Probability | 3 cr | MAT2572 | Introductions to Proofs and Logic | 4 cr |
| MAT2675 | Calculus III | 4 cr | MEDU1021 | Strategies for Mathematics Teachers | 3 cr |
| MEDU1010 | Foundations of Mathematics Education | 3 cr | | Peer Leader Training in Mathematics | 1 cr |
| COM1330 | Public Speaking | 3 cr | MEDU2901 | Methods and Materials for Special Needs Students | 3 cr |
| CE | Creative Expression | 3 cr | LibArt | Liberal Arts Elective | 3 cr |

| Semester 5 (16 credits) | | | Semester 6 (17 credits) | | |
|-------------------------|---|------|-------------------------|--|------|
| MAT3050 | Geometry | 4 cr | MAT3080 | Modern Algebra | 4 cr |
| MEDU3001 | Methods of Teaching Middle School Mathematics | 3 cr | MEDU3000 | Mathematics of the Secondary School Curriculum | 4 cr |
| EDU3610 | Human Learning and Instruction | 3 cr | MEDU3002 | Methods of Teaching Secondary School Mathematics | 3 cr |
| LibArt | Liberal Arts Elective | 3 cr | Add. Flex | Additional Flexible | 3 cr |
| ID | Interdisciplinary Course | 3 cr | Core | Common Core Course | |
| | | | Free | | 3 cr |
| | | | Elective | | |

| Semester 7 (14 to 17 credits) | | | Semester 8 (12 credits) | | |
|-------------------------------|--|-----------|-------------------------|-----------------------------------|------|
| MAT Elective | MAT2440, MAT2680, or MAT3075, MAT4030 | 3 or 4 cr | MEDU4000 | Student Teaching Seminar | 4 cr |
| MEDU3003 | Microteaching | 3 cr | MEDU4001 | Student Teaching in Middle School | 4 cr |
| EDU3670 | Methods of Literacy Instruction in Teacher Education | 3 cr | MEDU4002 | Student Teaching in High School | 4 cr |
| Free Electives | | 5 to 7 cr | | | |

Footnotes

¹ In meeting their general education requirements overall, students must take at least one advanced liberal arts course or choose two sequential courses in one of the world language (WL) course offerings, such as Arabic (ARB), Spanish (SPA), Chinese (CHN), or French (FREN).

² Specific courses listed indicate double duty courses, i.e., program degree requirements that also meet general education requirements. Choosing to take advantage of double duty can speed up progress toward graduation and increase elective credits. Consult with an advisor about your options.

³ Foreign Language - also satisfies WCGI

⁴ Students interested in pursuing graduate work in pure mathematics are advised to take MAT3075.

Course Alignment to Mathematics Accreditation Standards

The proposed curriculum meets mathematics standards of the NCTM for Secondary Mathematics Teacher Preparation Programs published in 2020. There are two components: *Knowing and Understanding Mathematics*; and *Technology and Representational Tools*. We consider each component below.

Note: The tables in this section were created by the following members of the Mathematics Education Committee: Corina Calinescu, Andrew Douglas, Laura Ghezzi, Bruce Kan, Nadia Kennedy, Boyan Kostadinov, Ariane Masuda, Andrew Parker, Jonas Reitz.

Knowing and Understanding Mathematics

The NCTM requires that teacher education candidates demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications within and among mathematical domains of Number; Algebra and Functions; Calculus; Statistics and Probability; Geometry, Trigonometry, and Measurement. In the tables below, we provide evidence that the mathematics courses in the proposed curriculum satisfy these requirements.

| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
|--|--|
| <p>1a) Essential Concepts in Number. Candidates demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of number including flexibly applying procedures, using real and rational numbers in contexts, developing solution strategies, and evaluating the correctness of conclusions. <i>Major mathematical concepts in Number include number theory; ratio, rate, and proportion; and structure, relationships, operations, and representations.</i></p> | <p>MAT1475 Calculus I: In this course students solve related rate problems and optimization problems for homework, assignments and tests. Solving them requires students to use ratio, rate and proportion. They also develop solution strategies.</p> <p>MAT2571 Introduction to Proof and Logic: Students analyze and prove elementary statements in number theory and set theory.</p> <p>MAT2580 Introduction to Linear Algebra: The scalar product of a vector by a scalar provides several opportunities for students to explore the proportion property. This includes the concept of a unit vector, and vector normalization.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: The course examines the content of the secondary school mathematics curriculum from an advanced perspective. Essential and foundational concepts in number are revisited and examined through a variety of approaches, with a special focus on the interplay between intuitive and formal understanding. Definitions are emphasized, as is the generalization of arithmetic properties and operations from natural numbers to integers, rationals, and reals. Pedagogical content</p> |

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| | knowledge is examined in discussions of mathematical concept representations, student errors, and the design of activities. |
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| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
|---|--|
| <p>1b) Essential Concepts in Algebra and Functions. Candidates demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of algebra and functions including how mathematics can be used systematically to represent patterns and relationships including proportional reasoning, to analyze change, and to model everyday events and problems of life and society. <i>Essential Concepts in Algebra and Functions include algebra that connects mathematical structure to symbolic, graphical, and tabular descriptions; connecting algebra to functions; and developing families of functions as a fundamental concept of mathematics. Additional Concepts should include algebra from a more theoretical approach including relationship between structures (e.g., groups, rings, and fields) as well as formal structures for number systems and numerical and symbolic calculations.</i></p> | <p>MAT1475 Calculus I: Assignments for this course require students to use algebra and proportions, to express ideas about functions and to interpret the analytic properties of these functions. They also set-up and solve problems about rates of change and optimization. Through assignments and on exams, including graph sketching problems, students learn to distinguish between classes of functions and to work with functions represented in multiple ways (by a formula, a table, a graph).</p> <p>MAT2571 Introduction to Proof and Logic: Students analyze and prove elementary statements in group theory.</p> <p>MAT2580 Introduction to Linear Algebra: Students are introduced to matrix transformations. In this context, the concepts of domain, codomain and image are emphasized. Students are required to identify the domain and codomain of matrix transformations defined by formulas and matrices. They also find the image of a vector in both ways.</p> <p>MAT3080 Modern Algebra: Students apply concepts, terminology, and theorems of group theory to solve problems and construct formal proofs. Students examine applications and relationships of group theory to geometry in class discussions, homework and tests.</p> <p>MAT3050 Geometry: Students solve problems and construct formal proofs dealing with group theory, emphasizing groups of transformations. Groups important to geometry that are considered include the Euclidean group of isometries of Euclidean space; and symmetry groups of geometric objects. The relationship between isometries and congruence is also examined.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: The course examines the content of the secondary school mathematics curriculum from an advanced perspective. In this course students compare and contrast algebraic properties of various number systems and families of functions, and examine the power provided by multiple conceptions of function (algebraic, geometric, formal and informal). Pedagogical content knowledge is examined in discussions of mathematical</p> |

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| | concept representations, student errors, and the design of activities. |
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| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
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| <p>1c) Essential Concepts in Calculus. Candidates demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of calculus including the mathematical study of the calculation of instantaneous rates of change and the summation of infinitely many small factors to determine some whole. <i>Essential Concepts in Calculus include limits; continuity; the Fundamental Theorem of Calculus; and the meaning and techniques of differentiation and integration.</i></p> | <p>MAT1475 Calculus I: This course serves as an introduction to the fundamental concepts of calculus in the program. It covers limits, continuity, rates of change, and differential calculus of one variable. It also has an introduction to integration including the Fundamental Theorem of Calculus. Applications include approximation of areas using Riemann sums.</p> <p>MAT1575 Calculus II: In this course students learn techniques for integration, improper integrals, infinite series and tests for convergence. The course also covers applications of integration, such as volumes of solids of revolution, areas between curves, and arc lengths of curves.</p> <p>MAT2675 Calculus III: Calculus III uses all of the fundamentals taught in previous courses to introduce and solve higher level problems. Topics include partial derivatives, double and triple integrals, and their applications.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: The course examines the content of the secondary school mathematics curriculum from an advanced perspective. In this course students revisit the main ideas of calculus with a sophisticated eye, looking carefully at conceptual underpinnings as well as operational fluency. Pedagogical content knowledge is examined in discussions of mathematical concept representations, student errors, and the design of activities.</p> |

| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
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| <p>1d) Essential Concepts in Statistics and Probability. Candidates demonstrate and apply understandings of statistical thinking and the major concepts, procedures, knowledge, and applications of statistics and probability including how statistical problem solving and decision making depend on understanding,</p> | <p>MAT1372 Statistics with Probability: Students collect, organize, summarize and visualize data using different types of graphs, which they analyze for shape and skewness, and interpret within context. They compute probabilities of events occurring as a result of random experiments, and interpret measures of central location and variability such as mean, median, percentiles, variance and standard deviation. They have to make</p> |

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| <p>explaining, and quantifying the variability in a set of data to make decisions. They understand the role of randomization and chance in determining the probability of events. <i>Essential Concepts in Statistics and Probability include quantitative literacy; visualizing and summarizing data; statistical inference; probability; and applied problems.</i></p> | <p>effective use of both probability and statistics terminology to set up and solve problems involving real data and applied problems, and make decisions based on the evidence. Students have to understand how statistical inference relies on a probabilistic analysis of random sampling. They consider real-world examples modeled by binomial, Poisson, normal, student-t, chi-squared and other probability distributions. They have to produce well-reasoned oral and written arguments using statistical evidence to support conclusions.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: The course examines the content of the secondary school mathematics curriculum from an advanced perspective. In this course students will practice the essential activities of extracting meaning from data and developing an intuition for probabilistic thinking. Pedagogical content knowledge is examined in discussions of mathematical concept representations, student errors, and the design of activities.</p> |
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| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
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| <p>1e) Essential Concepts in Geometry, Trigonometry, and Measurement. Candidates demonstrate and apply understandings of major mathematics concepts, procedures, knowledge, and applications of geometry including using visual representations for numerical functions and relations, data and statistics, and networks, to provide a lens for solving problems in the physical world. <i>Essential Concepts in Geometry, Trigonometry, and Measurement include transformations; geometric arguments; reasoning and proof; applied problems; and non-Euclidean geometries.</i></p> | <p>MAT1475 Calculus I: Students solve problems in optimization and related rates whose solutions use aspects of trigonometry, planar and solid geometry.</p> <p>MAT2675 Calculus III: Graphs and visual representations are a big part of Calculus 3. Students will see these in almost all of the topics taught.</p> <p>MAT1575 Calculus II: Students apply knowledge of integration to compute volumes of three dimensional solids by using different approaches: disks and washers and cylindrical shells. The specific geometry of the solid makes one method more appealing than the others.</p> <p>MAT2580 Introduction to Linear Algebra: Students are introduced to vectors in 2-space, 3-space, and n-space. Students demonstrate their understanding of the geometric interpretation of several concepts associated with vectors. This includes vector operations, norm, the distance formula between vectors, orthogonalization, and the projection theorem. Students learn about the concept of a normal vector to a line or a plane, and are introduced to the point-normal equations of the line and plane. Students solve problems where they need to recognize orthogonal planes and parallel planes. Students demonstrate their understanding of the geometric interpretation of the solutions of a system with 2 or 3 unknowns, if any.</p> |

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| | <p>MAT3050 Geometry: This course examines geometry from an axiomatic point of view. Students solve problems, construct formal proofs, and demonstrate geometric reasoning in Euclidean and Hyperbolic geometry in two and three dimensions on tests, weekly homework assignments, projects, and in-class group work. Students demonstrate their understanding of geometric concepts verbally during informal class discussions and in formal class presentations.</p> <p>Students make extensive use of GeoGebra to perform intricate constructions within advanced Euclidean geometry. Constructions utilizing inversion in circles are used to illustrate and explore standard results of hyperbolic geometry.</p> <p>Students demonstrate an understanding of connections of group theory to geometry via transformation groups. This includes the Euclidean group; groups of symmetries of geometric objects; and the consideration of congruence in terms of isometries.</p> <p>MAT2675 Calculus III: Graphs and visual representations are a big part of this course. Students will see these in almost all of the topics taught.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: The course examines the content of the secondary school mathematics curriculum from an advanced perspective. Focusing on foundational notions, such as transformations and their characteristics, drives deeper intuitive understanding of the geometry of the real world. Students will explore many connections between geometric and algebraic representations of mathematical objects, using these connections to enhance understanding in both areas. Pedagogical content knowledge is examined in discussions of mathematical concept representations, student errors, and the design of activities.</p> |
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| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
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| <p>2a) Problem Solving. Candidates demonstrate a range of mathematical problem-solving strategies to make sense of and solve non-routine problems (both contextual and non-contextual) across mathematical domains</p> | <p>MAT1475 Calculus I: In this course students solve related rate problems, and optimization problems for assignments and tests. Solving them requires students to use ratio, rate and proportion as well as to solve applied problems using units.</p> <p>Assignments and activities: in-class problem solving</p> |

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| | <p>sessions, quizzes, homework, WebWork. Projects involve analyzing an everywhere continuous, nowhere differentiable function and families of such curves. Assignments involve optimization of the beehive model and the structure of rainbows.</p> <p>MAT1575 Calculus II: In this course students rely on their skills in algebra to solve problems in integration for assignments and exams. They use inequalities to show convergence of series in assignments and on exams. Both for integration and convergence of series they learn to select from and apply a variety of techniques after formulating a plan on how to solve the problem. Assignments and activities: in-class problem solving sessions, quizzes, homework, videos and simulations.</p> <p>MAT2675 Calculus III: Students use double and triple integrals to solve applications such as finding the volume and mass of curved shapes. Problem solving strategies will also be on display when working with maximum and minimum problems.</p> <p>MAT3050 Geometry: This course introduces Geometry from an axiomatic point of view and develops much of standard Euclidean Geometry from these axioms. Frequently proofs or counterexamples have to be constructed by students, for example when checking Incidence Axioms of a given model, or when checking properties of the Taxicab Geometry, or when a congruence statement in Euclidean Geometry has to be proven. These skills are tested in exams and homework problems, which are also presented to and discussed with the whole class.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: The course examines the content of the secondary school mathematics curriculum from an advanced perspective. In doing so, students are encouraged to compare and contrast problem-solving strategies across a great breadth of mathematical content and domains. Pedagogical content knowledge is examined in discussions of mathematical concept representations, student errors, and the design of activities.</p> |
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| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
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| <p>2b) Reasoning and Communicating. Candidates organize their mathematical reasoning and use the language of mathematics to express their mathematical reasoning precisely, both orally and in writing to multiple audiences.</p> | <p>MAT1372 Statistics with Probability: Students study how to analyze data and use sample statistics to estimate population parameters. They have to translate word problems from plain English into the language of probability and statistics and organize their mathematical reasoning in order to make statistical decisions. One of the goals is to be able to explain statistical decisions to different audiences, using both technical and non-technical style.</p> <p>MAT1475 Calculus I: Calculus I includes setting up and solving problems on instantaneous rates of change, related rates and optimization. The emphasis is on translating word problems from English into the language of mathematics. These ideas are discussed in class, tested in homework problems and exams.</p> <p>MAT1575 Calculus II: Studying convergence of a power series requires multiple steps and reasoning. Students have to explain why/when a test is inconclusive, and how to handle special cases.</p> <p>MAT2571 Introduction to Proof and Logic: Students evaluate truth of statements in propositional and first-order logic. They reason in accordance with laws of propositional and first-order logic. And, they analyze and prove elementary statements with an emphasis on group theory, number theory and set theory.</p> <p>MAT2580 Introduction to Linear Algebra: The study of vector spaces requires students to organize their mathematical reasoning and make connections between several concepts in Linear Algebra. Topics include identifying a real vector space, a subspace, linearly independent/dependent vectors, basis, row space, column space, and null space.</p> <p>MAT3080 Modern Algebra: Students construct arguments and proofs in group theory and geometry. They regularly engage in critiquing classmates' proof attempts, discussing what constitutes a valid proof, and recognizing patterns in mathematical reasoning. Students develop an appreciation of mathematical rigor as a fundamental tool for mathematical inquiry.</p> <p>MAT2675 Calculus III: There are many high concept problems in Calculus III that require reasoning in both the setup and the execution of the solution. Topics include double and triple integrals, their applications, linear approximation, and Green's Theorem.</p> |

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| | <p>MAT3050 Geometry: Geometry is constructed from axioms. In particular, the Parallel Postulate, as well as its negations are investigated. Models which do or do not satisfy certain axioms are explored, including Four-point Geometry, Taxicab geometry, and non-Euclidean Geometries. Commonalities of properties of certain models are seen via commonalities of their postulates. These ideas are discussed in class, tested in exams, homework problems, and also in class presentations, which includes a written summary of the presentations.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: This course gives students a unique opportunity to revisit mathematical ideas from their own secondary education with an eye toward developing both their conceptual understanding and their ability to communicate that understanding to students of various mathematical backgrounds through a variety of means and modes. Pedagogical content knowledge is examined in discussions of mathematical concept representations, student errors, and the design of activities.</p> |
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| Component Number | Required Course Number(s) and Name(s) with a specific description of how the indicated component is addressed in the course(s) |
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| <p>2c) Mathematical Modeling and Use of Mathematical Models. Candidates understand the difference between the mathematical modeling process and models in mathematics. Candidates engage in the mathematical modeling process and demonstrate their ability to model mathematics.</p> | <p>MAT1372 Statistics with Probability: This subject is based on using mathematical models to understand random phenomena and analyze sample data to estimate population parameters as well as develop mathematical models from data using least squares, logistic and other forms of regression.</p> <p>MAT1475 Calculus I: Students set-up and solve problems about instantaneous rates of change, related rates, and optimization.</p> <p>MAT2675 Calculus III: Derivatives, integrals, polar coordinates, linear approximation, gradients, and many other topics in calculus 3 can be used for mathematical modeling.</p> <p>MAT3050 Geometry: Students apply geometric concepts in modeling situations. They examine applications of spherical geometry such as calculating latitude. Using GeoGebra, students construct geometric figures to create and test conjectures.</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum: Students have the opportunity to explore and engage with mathematical modeling and mathematical</p> |

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| | <p>models at all levels of the secondary school curriculum, from simple linear models to complex relationships rooted in calculus. Pedagogical content knowledge is examined in discussions of mathematical concept representations, student errors, and the design of activities.</p> |
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Technology and Representational Tools

The NCTM requires technology to be incorporated into the curriculum of a mathematics teacher preparation program. In the tables below, we describe the technology and representational tools, including concrete models, used in required courses that address each mathematical component. The tables establish that the Technology and Representational Tools components is met by the proposed curriculum.

| Component Number | Describe technology and representational tools, including concrete models, used in required courses that address components. Name the course, tools, and component by code (e.g., 1b) in the discussion of how candidates have multiple opportunities to learn with technology and representational tools across domains. |
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| 1a) Number and Quantity | <p>MAT1475 Calculus I; MAT1575 Calculus II; MAT2675 Calculus III:</p> <ol style="list-style-type: none"> 1. Web-based Desmos, as well as the Desmos App for iOS and Android. 2. Wolfram Alpha. 3. Maple. 4. WeBWorK for online homework. 5. MATLAB 6. R with RStudio. 7. Socrative web-based and apps used for assessment. 8. ShareLaTeX 9. PowerPoint 10. Trinket.io, a platform for running python scripts online 11. Videos from University of Houston. 12. PowerPoint 13. Use OpenLab, City Tech’s open digital platform for teaching, learning and collaboration, to complete written assignments and communicate with instructors and peers 14. Use the online tool sketchtoy.com to create and share graphs <p>MAT2580 Intro. to Linear Algebra:</p> <ol style="list-style-type: none"> 1. MATLAB. 2. PowerPoint <p>MEDU3000 Mathematics of the Secondary School Curriculum:</p> <ol style="list-style-type: none"> 1. Use OpenLab (WordPress), City Tech’s open digital platform for teaching, learning |

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| | <p>and collaboration, to complete written assignments and communicate with instructors and peers</p> <ol style="list-style-type: none"> 2. Youtube 3. Desmos (online calculator) 4. GeoGebra (online calculator) 5. Graphing Calculator (TI-84+, etc.) |
| <p>1b) Algebra and Functions</p> | <p>MAT2580 Intro. to Linear Algebra:</p> <ol style="list-style-type: none"> 1. MATLAB. 2. PowerPoint <p>MAT3080 Modern Algebra:</p> <ol style="list-style-type: none"> 1. Maple 2. GeoGebra <p>MEDU3000 Mathematics of the Secondary School Curriculum:</p> <ol style="list-style-type: none"> 1. Use OpenLab (WordPress), City Tech’s open digital platform for teaching, learning and collaboration, to complete written assignments and communicate with instructors and peers 2. Youtube 3. Desmos (online calculator) 4. GeoGebra (online calculator) 5. Graphing Calculator (TI-84+, etc.) 6. Graph paper |
| <p>1c) Calculus</p> | <p>MAT1475 Calculus I; MAT1575 Calculus II; MAT2675 Calculus III:</p> <ol style="list-style-type: none"> 1. Web-based Desmos, as well as the Desmos App for iOS and Android. 2. Wolfram Alpha. 3. Maple. 4. WeBWorK for online homework. 5. MATLAB 6. R with RStudio. 7. Socrative web-based and apps used for assessment. 8. ShareLaTeX 9. PowerPoint 10. Trinket.io, a platform for running python scripts online 11. Videos from University of Houston. 12. PowerPoint 13. Use OpenLab, City Tech’s open digital platform for teaching, learning and collaboration, to complete written |

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| | <p>assignments and communicate with instructors and peers</p> <p>14. Use the online tool sketchtoy.com to create and share graphs</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum:</p> <ol style="list-style-type: none"> 1. Use OpenLab (WordPress), City Tech’s open digital platform for teaching, learning and collaboration, to complete written assignments and communicate with instructors and peers 2. Youtube 3. Desmos (online calculator) 4. GeoGebra (online calculator) 5. Graphing Calculator (TI-84+, etc.) 6. Graph paper |
| <p>1d) Statistics and Probability</p> | <p>MAT1372 Statistics with Probability:</p> <ol style="list-style-type: none"> 1. R for statistical computing with RStudio 2. RStudio Cloud 3. R Markdown 4. Basic LaTeX in the context of R Markdown 5. MS Excel <p>MEDU3000 Mathematics of the Secondary School Curriculum:</p> <ol style="list-style-type: none"> 1. Use OpenLab (WordPress), City Tech’s open digital platform for teaching, learning and collaboration, to complete written assignments and communicate with instructors and peers 2. Youtube 3. Desmos (online calculator) 4. Graphing Calculator (TI-84+, etc.) 5. Spreadsheets (Google Sheets / Excel) 6. Graph paper |
| <p>1e) Geometry, Trigonometry, and Measurement</p> | <p>MAT2580 Intro. to Linear Algebra:</p> <ol style="list-style-type: none"> 1. MATLAB. 2. PowerPoint 3. GeoGebra <p>MAT3050 Geometry:</p> <ol style="list-style-type: none"> 1. Power Point 2. GeoGebra 3. Desmos |

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| | <p>4. Use OpenLab, City Tech’s open digital platform for teaching, learning and collaboration, to complete written assignments and communicate with instructors and peers</p> <p>MEDU3000 Mathematics of the Secondary School Curriculum:</p> <ol style="list-style-type: none"> 1. Use OpenLab (WordPress), City Tech’s open digital platform for teaching, learning and collaboration, to complete written assignments and communicate with instructors and peers 2. Youtube 3. Desmos (online calculator) 4. GeoGebra (online calculator) 5. Graphing Calculator (TI-84+, etc.) 6. Graph paper 7. Compass and straightedge |
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Chancellor’s Report Forms

Changes in Degree Programs

The following modifications are proposed for the Bachelor of Science in Mathematics Education
 Program: BSc in Mathematics Education
 Program Code: 35103
 Effective Date:

| FROM: | | TO: | |
|--|----------------------|--|------------------------|
| REQUIRED COURSES IN THE MAJOR | | REQUIRED COURSES IN THE MAJOR | |
| Mathematics Content Courses | | Mathematics Content Courses | |
| MAT1372 Statistics with Probability | 3 | MAT1372 Statistics with Probability | 3 |
| MAT1475 Calculus I | 4 | MAT1475 Calculus I | 4 |
| MAT1575 Calculus II | 4 | MAT1575 Calculus II | 4 |
| MAT2571 Intro. To Proofs and Logic | 4 | MAT2571 Intro. To Proofs and Logic | 4 |
| MAT2580 Intro. to Linear Algebra | 3 | MAT2580 Intro. to Linear Algebra | 3 |
| MAT2675 Calculus III | 4 | MAT2675 Calculus III | 4 |
| MAT3050 Geometry | 4 | MAT3050 Geometry | 4 |
| MAT3075 Intro. to Real Analysis | 4 | MAT3080 Modern Algebra | 4 |
| MAT3080 Modern Algebra | 4 | | |
| MAT4030 History of Mathematics | 3 | One of <u>MAT2440, MAT2680, MAT3075, or MAT4030.</u> | <u>3 or 4</u> |
| Subtotal | 37 | Subtotal | <u>33 or 34</u> |
| Free Electives Courses | 6 | Free Electives Courses | <u>10</u> |
| Take additional credits, if necessary, to make 120 credits | | Take additional credits, if necessary, to make 120 credits | |
| Program Total | 120 | Program Total | 120 |