BOARD OF HIGHER EDUCATION
REQUEST FOR BOARD ACTION

NO.:BHE 26-24

BOARD DATE: October 1, 2025

APPROVAL OF LETTER OF INTENT OF UMASS LOWELL TO AWARD THE DOCTOR OF PHILOSOPHY IN MATHEMATICS AND AUTHORIZATION FOR FAST TRACK REVIEW

MOVED: The Board of Higher Education (BHE) has evaluated the Letter of Intent of **UMASS Lowell** to award the **Doctor of Philosophy in Mathematics** and has determined that the proposal aligns with BHE criteria. Accordingly, the BHE authorizes the Commissioner to review the program and to make a final determination on degree granting authority pursuant to the Fast-Track review protocol.

VOTED: Motion adopted by the BHE on 10/1/2025.

Authority: Massachusetts General Laws Chapter 15A, Section 9(b); AAC 18-40

Contact: Richard Riccardi, Sc.D., Deputy Commissioner for Academic Affairs and Student Success

DEGREE TITLE ABSTRACT ON INTENT AND MISSION OF PROGRAM

The Department of Mathematics and Statistics at the University of Massachusetts Lowell proposes to offer a Ph.D. degree in Mathematics. As new scientific discoveries and technological developments are creating new fields where math is explored and applied, prompting a wide range of career opportunities for experts and professionals with mathematical skills and talent, the proposed degree program will significantly expand the current mathematical professional development paths offered at UML. A Ph.D. program in Mathematics at UML will contribute to the University's status as a research institution and to the fulfillment of the rising demands for highly skilled mathematicians in Massachusetts and across the nation. Candidates in the proposed degree program will be equipped with the mathematical skills to pursue a broad range of careers in math, science, engineering, finance, actuarial science, management, optimization, operations research, medical imaging, quantum computing, mathematical biology, machine learning and data science. This proposition will contribute to the university's 2028 strategic plan to foster innovative and creative research and scholarship. Furthermore, the proposed degree program will support the University's plan to push toward R1 status and continued research growth in all disciplines as data science and statistical approaches become an integral part of all forms of scholarship.

The proposed Doctor of Philosophy in Mathematics program was approved by UMass Lowell's Board of Trustees on February 3, 2025. The LOI was circulated on April 15, 2025. No comments were received.

A. **ALIGNMENT WITH MASSACHUSETTS GOALS FOR HIGHER EDUCATION**

Address Gaps in Opportunity and Achievement in Alignment with Campus-Wide Goals

The Department of Mathematics and Statistics is, proudly, one of the main service providing departments on campus. It will proudly and successfully serve graduate students who wish to pursue a math career. UMass Lowell serves over 40% students of color, and over 40% first generation students. By now, several students, including students from minority communities, pursued a Ph.D. in the computational math route offered in conjunction with the Miner School of Computer and Information Sciences. However, many more wished to pursue a Ph.D. in different disciplines of mathematics. With the proposed degree program, the department will accommodate this demand and provide such options for students from the greater Lowell area, from outside the state and for international students who are looking for a Ph.D. in specific fields of mathematics.

Program or Department Supports to Ensure Student Retention and Completion

In the past decade, the Department of Mathematics and Statistics has hired talented researchers and teachers from diverse fields of mathematics and statistics. By now, research activity in the department has been significantly boosted with research-productive and research-intensive faculty members who publish in top scientific journals, host conferences and are awarded research grants. Furthermore, by employing such funds, in the past 3 years, the department began to host post-doctoral fellows, in addition to Ph.D. students in the computational math program. During this time, repeatedly, talented bachelor's and master's degree students at UML, as well students from other universities, have shown interest in a more general Ph.D. program and wished for one to be offered in mathematics at UML. Several of these interested students went on to pursue a Ph.D. in Math at other institutions. It has become a common interest, for almost all members in the department, to be able to offer a Ph.D. route to our students, to bring in talented Ph.D. level researchers who will contribute to the growing research activity and competitiveness for grant support in the department.

Currently, the department offers a Master of Science in Mathematics program and participates in a Ph.D. in computational mathematics offered through the Miner School of Computer and Information Sciences. In addition, in the past several years, new graduate courses have been developed to enrich offerings of the MS Math program and to prepare for a prospective Math Ph.D. program.

Ph.D. math students are usually hired as teaching assistants. Teaching experience is a standard component in a CV of any mathematician seeking an academic job after obtaining their Ph.D. degree. The department has developed a training course (MATH.5020 Teaching College Mathematics) that prepares graduate students for teaching at the college level. This training course focuses on helping prospective college mathematics instructors to develop pedagogical knowledge in mathematics. Topics include equitable and inclusive teaching practices, assessing student work, lesson planning, inquiry-based learning, effective questioning in the classroom and student engagement. Students will have opportunities to observe classrooms, practice teaching short lessons with their peers, as well as design and teach lessons in real classrooms.

Alliances and Partnerships with PK-12, Other IHE's, Community Employers

The department has been playing an important role in the UTeach program at UMass Lowell and the Math Mill:

- The UMass Lowell UTeach program prepares students to teach in STEM areas at the K-12 level. By completing the STEM Teaching Minor, they graduate with a teaching certificate along with their bachelor's degree. Since 2014, 90 students have earned their certificates, 56% of them were mathematics majors. As of Spring 2024, there are 33 graduates who are known to be teaching in Massachusetts schools. Many graduates maintain contact with the Mathematics and Statistics Department by taking graduate classes. A master's degree is required for the next level of certification.
- The Math Mill (https://www.themathmill.org/) is a math circle in the Merrimack Valley that holds its meetings at the UML campus. It was founded in 2020 through a collaboration of local educators, including UML faculty from the Department of Mathematics and Statistics and the School of Education. One of the goals of The Math Mill is to support math educators at all levels in the Merrimack Valley by fostering a community focused on learning and teaching mathematics. The Math Mill always welcomes new members and is always on the lookout for math educators who are interested in holding sessions. In fact, some UTeach program graduates are actively participating in The Math Mill.

These two programs, combined with the proposed degree program, will foster and cultivate future educators and researchers. The Math Mill will also serve future Ph.D. candidates in Mathematics at UML to engage with the broader Merrimack Valley math community.

In addition, there have been several students who pursued Ph.D. degrees in Computational Mathematics, sponsored by their employers. The department plans to further reach out to tech companies in the greater Boston area to advocate for a Ph.D. possibility for employees, who will potentially be sponsored by their employers while pursuing their degree part-time or full-time. The anticipated boost in research output as a result of this proposed degree program will contribute to the university's 2028 strategic plan to foster innovative and creative research and scholarship.

Relationship to MassHire Regional Blueprints

Mathematics is the fundamental tool for modeling, analyzing, programming and developing scientific and engineering theories, methods and processes. Math has a very long and well-established track record as an independent field of exploration. New scientific discoveries and technological developments are creating new fields where math is explored and applied, prompting a wide range of career opportunities for experts and professionals with mathematical skills and talent. Graduate students from mathematics programs at UML found jobs opportunities in fields of education, data science, statistics, operations research, finance, and engineering.

As of February 2024, the high-level review for Doctoral/Professional Degree in Mathematics from Hanover Research (https://www.hanoverresearch.com) recommends that, based on the combination of student and labor demand, the outlook for such program in the New England region is considered High Growth. This typically represents strong opportunities for program development or expansion of existing programs.

- On the student demand side, Doctoral/Professional programs in Mathematics grew at a faster rate than the average for all programs at this graduation level. Over the past five years, conferrals from Doctoral/Professional programs in Mathematics grew at a rate of 2.5%, compared to 1.9% for all programs at this level. Furthermore, in 2022, institutions reported a total of 105 graduates in this field, compared to an average of 37 across all Doctoral/Professional programs.
- In terms of labor demand, Doctoral/Professional programs in Mathematics align with occupations projected to grow at a faster rate than the average for all occupations. Based on 10-year forecasts, employment among occupations aligned with this proposed degree program is

projected to grow at a rate of 3.6%, compared to 0.1% for all occupations. In terms of volume, aligned occupations are projected to offer 5,606 openings each year due to growth and separations, compared to 1,054 across all occupations.

In contrast, the outlook for the same programs at the national level is considered Mixed:

- On the student demand side, Doctoral/Professional programs in Mathematics grew at a slower rate than the average for all Doctoral/Professional programs. Over the past five years, conferrals from Doctoral/Professional programs in Mathematics grew at a rate of 1.8%, compared to 2.6% for all programs at this level. However, the number of graduates in this field is higher than average: In 2022, institutions reported a total of 1,264 graduates in this field, compared to an average of 237 across all Doctoral/Professional programs.

- In terms of labor demand, Doctoral/Professional programs in this field align with occupations projected to grow at a faster rate than the average for all occupations. Based on a 10-year forecast, employment among occupations aligned with these programs is projected to grow at a rate of 6.1% compared to 2.8% for all occupations. In terms of volume, aligned occupations are projected to offer 99,600 openings each year due to growth and separations, compared to 22,315 across all occupations.

Data from the Bureau of Labor Statistics for the period 2021-2031 also supports these findings.

With the proposed degree program, UML will be able to prepare students with knowledge, skills and know-how for emerging job opportunities and demands in this field. On the other hand, the proposed degree program will not only expand the current mathematical professional development paths offered at UML, but also the network of UML mathematics alumni working in those fields which, in turn, will serve as a great resource for career advice and preparation.

Duplication

Once the proposed degree program is approved, UMass Lowell will be the first and only public institution in the greater Boston area to offer a Ph.D. in Mathematics program. While, in principle, the proposed degree program will be comparable with programs at other, private, institutions, by covering multiple mathematical fields ranging from fundamental areas such as analysis, algebra, topology, geometry, to more applied areas such as numerical analysis, computational mathematics, machine learning, data

science, etc., a Ph.D. Math program at UMass Lowell will address more localized needs, emerging from our interactions and experience with students, prospect students, interested parties from the industry and colleagues from local higher education institutions:

- A significant number of our students expressed interest in obtaining a Ph.D. in Math at UMass Lowell. Several of these students are currently pursuing their Ph.D. at other institutions, after obtaining an MS degree in Mathematics at UMass Lowell.
- Several of our former MS students, currently in the industry, have shown interest in a part-time Ph.D. option during their employment. Some did pursue this option via the Ph.D. in Computational Mathematics route. Offering a general Ph.D. in Math will increase these numbers.
- Two mathematics lecturers at UMass Boston obtained an MS in Mathematics degree at UMass Lowell and one is currently pursuing the degree to develop their teaching career in their department. Offering a general Ph.D. in Math will grow these numbers and attract faculty members from the UMass system who already hold an MS degree in Math.
- Several adjunct faculty members from UMass Lowell expressed interest in pursuing Ph.D. in Math at UML. Offering a general Ph.D. in Math will provide a route for significant professional development and will set a higher bar of proficiency in our instructors, providing them with research and other career development opportunities.
- Several of our MS students are math instructors at local community colleges. Of these, several showed interest in a Ph.D. degree. Requiring a Ph.D. in Math is becoming a norm for NTT faculty, in UMass Lowell and other higher education institutions. A general Ph.D. program in Math will address such demand, locally, to begin with, and may evolve into a well-recognized route for teaching faculty statewide and beyond.
- Inquiries regarding a Ph.D. in Math from abroad by prospect international students are constantly being sent to faculty in the department. Having a general Ph.D. Math program will provide opportunities for talented international students interested in our faculty's research.

Innovative Approaches to Teaching and Learning

One of the foci of the proposed degree program is on training the next generations of math researchers and educators by developing applicable necessary skills in current and ever-changing state-of-the-art technologies. Therefore, it is our mission to ensure that all students, especially Ph.D. students, are exposed to innovative and contemporary pedagogical approaches in education. Indeed, experiential, and

competency-based learning have been used and widely received in undergraduate mathematics courses at UML. The department commits to further expanding these modern approaches to the entire curriculum whenever possible.

B. ALIGNMENT WITH CAMPUS STRATEGIC PLAN AND MISSION

An influx of talented Ph.D. students into the department will contribute to our teaching mission by providing expert teachers for all course levels. The addition of a Ph.D. program in mathematics would also meet the goal of the Kennedy College of Science to expand its doctoral offerings across all six of its departments. Furthermore, a math Ph.D. program at UML will become a pathway connecting scientific disciplines and a catalyst that will enhance academic interactions across departments, which will, in turn, lead to new fundable collaborative research.

Goals and Objectives (Form B)

Candidates in the proposed degree program will be equipped with the mathematical skills to pursue a broad range of careers in math, science, engineering, finance, actuarial science, management, operations research, machine learning within data science, optimization theory, applications to global energy management, signal processing and medical imaging, quantum computing, mathematical biology, and mathematical computing in STEM, to name a few. Candidates for the proposed degree program must complete 54 credit hours beyond the bachelor's degree, including a minimum of 30 credit hours of coursework and a minimum of 18 credit hours of dissertation work. In addition, students will be required to pass basic qualifying exams in all main fields of math while additional qualifying exams will be developed based on the student's field of research in conjunction with the supervisor. The strong and diverse faculty in the department will support the academic needs of incoming graduate students, in particular, by offering core advanced courses in the major mathematical fields of analysis, algebra, topology and geometry. Additionally, more specialized topics will be offered occasionally, upon demand.

C. ALIGNMENT WITH OPERATIONAL AND FINANCIAL OBJECTIVES OF INSTITUTION

Enrollment Projections (Form C)

As a pilot program, in Spring 2023 the math department employed 4 Teaching Assistants (TA). In Fall 2023, Spring 2024 and Fall 2024, this number grew to 6. The TAs were assigned with supplementary instruction (SI) sessions for Pre-Calculus courses. Most of the students benefit from SI classes since they can spend more supervised time digesting the materials, have the chance to solve problems and ask questions. In Fall 2023, several TAs completed the teaching training via MATH.5020 Teaching College Mathematics. Two of these TAs were assigned as instructors of record of one or more Pre-Calculus sections in Spring 2024. In Fall 2024, the course MATH.5020 has the enrollment of 11 students (vs. Fall 2023 enrollment of 4 students), three of whom will be assigned as instructors of record in Spring 2025.

Based on this success, the department requests the support of the university to gradually expand the current TA program to enable the department to sustain 10 Ph.D. students.

Resources and Financial Statement of Estimated Net Impact on Institution
(Form D, Appendices)

After conducting research about comparable departments in several state universities, and with information from other departments in the Kennedy College of Sciences, the department concluded that the model of support for a Ph.D. candidate is rather standard and largely similar among peer higher education institutions. In each institution, the financial mechanism incorporates several standard components as follows:

- A teaching assistantship program: Ph.D. students serve as teaching assistants, either as instructors of basic service courses, or as tutors and graders. The workload varied between institutions. At some very well-established institutions, the workload was one 3 credit-hour course per semester, while at others the workload was heavier.
- The duration of university support is up to 5 years.
- Faculty member grants will support students as Research Assistants allowing these students to dedicate more effort to their research. Externally funded grants will also pay for travel, equipment and other research expenses.
- Established endowed awards and scholarships from donors and departmental funds.

With the current rates, based on existing Ph.D. candidates in the computational math program, the total cost of a Ph.D. student per year ranges from $33,176 to $48,288 depending on residency (in-state/out-of-

state) and TA/RA scale. However, the proposed teaching assistant program for the new Ph.D. in Mathematics would include having Ph.D. students formally teach mathematics courses in the place of adjunct and full-time faculty members. Thus, by not hiring instructors for classes covered by the TAs (item Reallocated Fund in Form D: Program Budget), the net cost of the TA program would be quite a bit less than the total cost.

Also, in departments with more abundant grant awards, steady university support is the backbone of their Ph.D. programs. Most significant math grants are for 3 years while, when accepting a Ph.D. student, one must be ready to commit for 4-5 years of constant and guaranteed support, provided that the student's performance is satisfactory. Grants are most influential in allowing excellent students to focus on their research by buying out their assigned teaching loads and supporting them as research assistants. Grants also pay for other research expenses such as travel and equipment.

Teaching assistantship is a crucial and an essential part in the training of Ph.D. candidates. Teaching experience is a standard component in a CV of any mathematician seeking an academic job after obtaining their Ph.D.

STAFF REVIEW AND VALIDATION

Staff thoroughly reviewed the **LOI** proposing full degree granting authority for the **Doctor of Philosophy in Mathematics** program submitted by **UMASS Lowell**. Staff validate that the **LOI** includes all data required by the Massachusetts Board of Higher Education. Staff recommendation is for BHE authorization for the Commissioner to review the program pursuant to the Fast-Track review protocol.

Form A: Curriculum Outline

Required (Core) Courses in the Major (Total # courses required = 22)		
Course Number	Course Title	Credit Hours
MATH.5010	Real Analysis	3
MATH.5090	Probability and Mathematical Statistics	3
MATH.5110	Complex Variables	3
MATH.5210	Abstract Algebra	3
MATH.7060	Directed Research (not counted as standard course)	18
	Sub-total # Core Credits Required	30
Elective Course Choices (Total courses required = 6) *(attach list of choices if needed)*		
MATH.5/6xxx	(Graduate Math Courses)	3
MATH.5/6xxx	(Graduate Math Courses)	3
MATH.5/6xxx	(Graduate Math Courses)	3
MATH.5/6xxx	(Graduate Math Courses)	3
MATH.5/6xxx	(Graduate Math Courses)	3
MATH.6510	Topics in Mathematics	3
	Sub-total # Elective Credits Required	24
Curriculum Summary		
	Total number of courses required for the degree	16
	Total credit hours required for degree	54

Prerequisite, Concentration or Other Requirements:

Ph.D. candidates are required to pass basic qualifying exams in all main fields of math while additional qualifying exams will be developed based on the student's field of research in conjunction with the supervisors.

Form B: LOI Goals and Objectives

Goal	Measurable Objective	Strategy for Achievement	Timetable
Competent in standard graduate mathematics coursework	Complete required graduate coursework	The department will support the academic needs by offering core advanced courses in major mathematical fields of analysis, algebra, topology, geometry, as well as specialized topics.	Year 1 and 2
Prepared for conducting research in fields of interest	Pass Qualifying Exams on students' field of research	Mathematics Faculty will develop comprehensive qualifying exams based on students' research interests.	Year 2 or 3
Competent in fields of research	Publications in Mathematics Journals	Research are conducted with students' advisors (MATH.7060 Directed Research)	Year 4 or 5
(For Teaching Assistants) Prepared for teaching mathematics at college level	Teaching Assistants are required to pass MATH.5020 Teaching College Mathematics	Activities to develop teaching practices, assessing student work, lesson planning, inquiry-based learning, effective questioning in the classroom, and student engagement. Students will have opportunities to observe classrooms, practice teaching short lessons with their peers, as well as design and teach lessons in real classrooms.	First semester

Form C: LOI Program Enrollment

	Year 1	Year 2	Year 3	Year 4	Year 5
New Full-Time	6	2	2	0	0
Continuing Full-Time	0	6	8	10	10
New Part-Time	1	1	1	1	1
Continuing Part-Time	0	1	2	3	4
Totals	7	10	13	14	15

Form D: LOI Program Budget

One Time/ Start Up Costs		Annual Expenses				
	Cost Categories	Year 1	Year 2	Year 3	Year 4	Year 5
	Full Time Faculty (Salary & Fringe)					
	Part Time/Adjunct Faculty (Salary & Fringe)					
	Staff					
	General Administrative Costs					
	Instructional Materials, Library Acquisitions					
	Facilities/Space/Equipment					
	Field & Clinical Resources					
	Marketing	$10,000	$10,000	0	0	0
	Other (Specify) Graduate Teaching Assistant Stipends ($22,983/yr each)	0	$22,983	$45,966	$68,949	$91,932
	Other (Specify) TA Fringe ($2,627/yr each)	0	$2,627	$5,254	$7,881	$10,508

One Time/Start-Up Support		Annual Income				
	Revenue Sources	Year 1	Year 2	Year 3	Year 4	Year 5
	Grants					
	Tuition $15,330/yr each (in-state) $27,706/yr each (out-of-state)	Remitted	Remitted	Remitted	Remitted	Remitted
	Fees	$0	$720	$1,440	$2,160	$2,880

	$720/yr each (in/out-state)				
	Departmental				
	Reallocated Funds Savings from not having to hire instructors for sections covered by TAs	$0	$27,600	$55,200	$82,800	$110,400
	Other (specify)				
	TOTALS	($10,000)	($2,290)	$5,420	$8,130	$10,840