Academic Program Approval Voting Record

This document is to be appended as the last page of the proposal for any new or revised academic program to record the successive votes of approval as the proposal moves through its required review and approval steps. Consult Faculty Handbook Section 10.8 or the Faculty Senate Curriculum Committee website for information regarding Committee review and voting requirements for each action.

Curricular Action: (check appropriate boxes below)

1. X New Program  □ Name Change  □ Discontinuation  □ Concurrent Degree for:

2. □ Undergraduate Major  □ Graduate Major  □ Undergraduate Minor  □ Graduate Minor
   □ Undergraduate Certificate  X Graduate Certificate  □ Other: ____________________

3. Name of Proposed Change: _Postbaccalaureate Certificate in Mathematics___________

4. Name of Contact Person: _Michael Young_  e-mail address: __myoung@iastate.edu_______

5. Primary College: _LAS_________________ Secondary College: __________________________

6. Involved Department(s): _Mathematics__________________________
   ____________________________________________________________

Voting record for this curricular action:

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<tr>
<th>Voting Body</th>
<th>Votes</th>
<th>Date of Vote</th>
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<td>Dept. or Program Committee</td>
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<tr>
<td>--Department of Mathematics</td>
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[FSCC – November 2013]
The Department of Mathematics is bringing forward the proposal attached below for a Graduate Certificate in Mathematics.

1. **Name of the proposed graduate certificate.**
   
   Postbaccalaureate Certificate in Mathematics

2. **Name of the departments and/or programs involved.**

   Department of Mathematics

3. **Name of the contact person.**

   Michael Young myoung@iastate.edu

4. **Need for the graduate certificate.**

The certificate is designed for students to fortify their preparation to be able to succeed in a timely way in a PhD program. For a variety of reasons, including time off since undergraduate education due to family needs, military service, workforce participation, etc., there are numerous strong students who are motivated to earn STEM doctoral degrees but lack the preparation to succeed in a doctoral program without additional support.

This certificate follows the model of the nationally recognized Women in Mathematics Postbaccalaureate Program at Smith College (see description below). The Smith program has national recognition (e.g., it won the American Mathematical Society 2011 Award for Programs that Make a Difference) and its graduates were recruited by strong doctoral programs (including ISU). Prof. Ruth Haas, the founder of the Smith program, will advise our certificate program during our yearly informal review.

The Smith postbaccalaureate program is for women with bachelor's degrees who did not major in mathematics or whose mathematics major was light. It is designed to make them graduate-school-ready in one year. More details about that program are available online at [https://www.smith.edu/academics/mathematics-statistics#center](https://www.smith.edu/academics/mathematics-statistics#center). As the table below indicates, the program at Smith produced good results. However, the program is not admitting new students due to NSF funding ending (they do not have a PhD program in Math at Smith and that, along with the high tuition at Smith, created limitations for sustaining their efforts)
Prof. Ruth Haas kindly provided to us statistics of the Smith program from 2007 to 2016. A summary is given in the following table.

<table>
<thead>
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<th># of students</th>
<th>Completed postbac</th>
<th>Under-represented</th>
<th>Entering graduate program</th>
<th>Entered graduate program</th>
<th>Earned PhD</th>
<th>In PhD program</th>
<th>Dropped out</th>
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<td>11</td>
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Our program will be similar to the program at Smith, but with key differences since our graduate certificate would be offered within a department at a land grant university with a thriving PhD program.

Current options for students needing additional preparation include either enrolling for a Masters degree or enrolling for a PhD (if the student is accepted). Both pathways have disadvantages. Within the discipline of mathematics, Masters programs have a somewhat negative reputation as a path to the PhD. The perception is that Masters degree is a consolation for those who do not earn a PhD (if the same institution also awards PhD degrees). Students who are accepted to both masters and PhD programs are often advised to try the PhD even with the expectation they will struggle. By contrast to the MS, postbaccalaureate programs have a good reputation, primarily due to the Smith Postbaccalaureate program.

In general, students at graduate school recruiting fairs (such as SACNAS or Field of Dreams Conference) often ask about the option of a postbaccalaureate program, and some choose to take an extra year of courses at their undergraduate school (which is usually weaker than this proposed certificate), if they are unable to enroll in a postbaccalaureate program. The Mathematics Graduate programs already recruit at various conferences that target underrepresented students, and at the recent Field of Dreams Conference a dozen students expressed interest in a Postbaccalaureate Graduate Certificate offering at Iowa State.

We plan to build a cohort of certificate students with mentoring support to encourage them to take the courses that best meet their needs. The proposed program will place students primarily in existing non-core graduate courses and some new dual-listed courses. The proposal of this graduate

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1 The most difficult courses offered by the Mathematics and Applied Mathematics Graduate Programs are the core courses that prepare students for PhD qualifying examinations. Despite being numbered at the 500 level, these are very intense courses that assume excellent undergraduate preparation and are not likely to be suitable for the certificate students we envision (a student who can succeed in these courses should be enrolled for the PhD). The following are core courses: Algebra MATH 504, MATH 505, MATH 510; Analysis MATH 511, MATH 515, MATH 516; Discrete Mathematics MATH 566, MATH 567, MATH 568; Applied Mathematics MATH 519, MATH 520, MATH 557; Numerical Analysis Math 517, MATH 561, MATH 562.
certificate fits nicely with department plans to increase opportunities for our upper division math majors since new courses will be dual listed.

NSF has officially recognized postbaccalaureate programs as “time-off-the-clock” in terms of eligibility for the NSF Graduate Research Fellowship Program.

5. Objective of the graduate certificate.

The objective is to bridge the gap in knowledge and advising for strong students, who graduated from undergraduate institutions and are interested in pursuing further study in mathematics, but may have missed some key coursework essential to success in PhD programs in mathematics or simply may not yet be confident in their preparation. In addition, students who were outside of academia for a significant amount of time, for example military, family, or health reasons, might benefit from this bridge program. Other interested students may come from those who were trained in pure math (many US undergraduate colleges offer only limited applied mathematics training) and are interested in a graduate certificate that would prepare them for an applied math PhD. In some few cases the certificate might also serve as an exit plan for PhD or MS students, who struggled in these programs or need to leave after a year, but who could still manage to satisfy the criteria for the certificate. The certificate may improve employment opportunities over a bachelor’s degree, particularly if the certificate includes some work in applied mathematics, numerical analysis, and/or statistics and an internship.

6. General description of the graduate certificate.

The Postbaccalaureate Certificate in Mathematics is a certificate program that offers students who have received Bachelor’s degrees a year of training and preparation for entering a PhD program. The main goal of the program is to prepare students to be successful in advanced graduate studies in mathematics and to experience graduate school. The program targets underrepresented groups in mathematics, which includes women, students of color, and veterans. It also welcomes students who finished their undergraduate degree but were unable to continue with their academic career due to family or medical reasons.

In this program students will take courses, have teaching assignments in undergraduate courses\(^2\), get ample mentoring from the department’s faculty and advanced graduate students, attend conferences, and receive professional development to aid in applying for graduate programs (or jobs, if necessary). Students will receive stipends and tuition through TAships. The department has applied for NSF funding (NSF DCL 17-078 “Improving and Supporting the Transition to Graduate School in the Mathematical Sciences”) to get supplementary funding for additional resources, including the development of additional courses. Students will also be encouraged and assisted in applying for outside funding for workshops and conferences. If we do not receive NSF funding, the department will move forward with the certificate program, but more slowly. Some of the courses needed already

\(^2\) This will require modification of current policies by the Graduate Council. The Graduate Handbook section 3.2 currently reads “Only degree-seeking students (Ph.D. and master’s degrees) may be appointed to a graduate assistantship.”
exist or are in development. These courses will serve a smaller initial cohort, and can be expanded gradually as resources permit.

Students will take a total of 13 credits, including 12 graduate course credits and 1 seminar credit to earn the certificate. The program of study should prepare the student to enter a doctoral program in mathematics or applied mathematics, and the graduate courses should be selected with a focus on pure or applied mathematics (See Section 7 Requirements). Graduate courses will normally be chosen from the following list (those with an X are experimental courses or are being developed, with a plan to offer Math 503X, 518X, and 581X in the first year). Each of the 10 courses that will be primary options for students will fall into one of the following three categories: Courses that currently exist (5 running courses, 1 in proposal state); courses that are a redesign and/or a renumbering of current courses (2 courses); courses that may be newly created (2 courses).

- Math 501 Introduction to Analysis, 3 credits, Fall, (existing course)
- Math 507 Applied Linear Algebra, 3 credits, Fall, (existing course)
- Math 591/592 Orientation For Mathematics Graduate Students I and II (both existing courses)
- Stat 500 Statistical Methods I, 4 credits, Fall, (existing course)
- Math 518X Introduction to applied mathematics and partial differential equations, 3 credits, Fall, (a graduate course has been proposed independent of and before this graduate certificate proposal, potentially dual listed as a new undergraduate course)
- Math 503X Applied Algebra, 3 credits, Spring, (a dual listing, redesign and renumbering of an existing undergraduate course)
- Math 581X Introduction to Numerical Analysis, 3 credits, Spring, (a dual listing and redesign of an existing undergraduate course)
- Math 565X Introduction to mathematical modeling, 3 credits, Spring (potential new course)
- Math 569X Introduction to discrete mathematics, 3 credits, Spring (potential new course)

In addition to these classes, certificate students with strong interests and sufficient background might take also other graduate classes. These redesigned, dual listed or new courses will serve advanced undergraduate students, as well as provide an opportunity for Masters and PhD students to explore topics outside of their main research area. This will better prepare our undergraduate students for graduate programs and create graduate students with wider breath of knowledge, which is particularly important for those interested in teaching at a liberal arts college.

**Existing Courses**

*MATH 501 Introduction to Real Analysis*

(3-0) Cr. 3. F.

*Prereq: MATH 265 and (MATH 207 or MATH 317)*

A development of the real numbers. Study of metric spaces, completeness, compactness, sequences, and continuity of functions. Differentiation and integration of real-valued functions, sequences of functions, limits and convergence, equicontinuity.
MATH 507 Applied Linear Algebra
(Dual-listed with MATH 407). (3-0) Cr. 3. F.
Prereq: MATH 317; or MATH 207 and experience writing proofs
Advanced topics in applied linear algebra including eigenvalues, eigenvalue localization, singular value decomposition, symmetric and Hermitian matrices, nonnegative and stochastic matrices, matrix norms, canonical forms, matrix functions. Applications to mathematical and physical sciences, engineering, and other fields.

MATH 591 Orientation For Mathematics Graduate Students I
(0.5-0) Cr. 0.5. F.
Fall semester orientation seminar. Required for graduate students in Mathematics and Applied Mathematics. Topics include teaching at the university level and communication of mathematics. Offered on a satisfactory-fail basis only.

MATH 592 Orientation For Mathematics Graduate Students II
(0.5-0) Cr. 0.5. S.
Spring semester orientation seminar. Required for graduate students in Mathematics and Applied Mathematics. Topics include teaching at the university level and communication of mathematics. Offered on a satisfactory-fail basis only.

STAT 500 Statistical Methods I
(3-2) Cr. 4. F.
Prereq: STAT 447 or current enrollment in STAT 542; knowledge of matrix algebra.
Analysis of data from designed experiments and observational studies. Randomization-based inference; inference on group means; nonparametric bootstrap; pairing/blocking and other uses of restricted randomization. Use of linear models to analyze data; least squares estimation; estimability; sampling distributions of estimators; general linear tests; inference for parameters and contrasts. Model assessment and diagnostics; remedial measures; alternative approaches based on ranks.

Math 518X Introduction to applied mathematics and partial differential equations
(Potentially dual-listed with new MATH 418X). (3-0) Cr. 3. F.
Prereq: MATH 265 and (MATH 266 or MATH 267) and MATH 414
Basic theory of ordinary differential equations, existence and uniqueness theorems, linear systems, linearization and stability, ODE models in biology and physics, modeling with partial differential equations, dynamical systems techniques.
The Department is discussing whether to upgrade the existing MATH 385, which is currently rather computational, or create a more theoretical undergraduate version 418X (there are currently students form other departments in 385 who needs must be considered).
Redesigned/Renumbered Courses

**Math 503X Algebra and Applications**
(Dual-listed with existing MATH 403:=302). (3-0) Cr. 3. S.
Groups, rings, fields, Lie algebras and applications. Emphasis on rings and fields.
Math 302 will be revised and renumbered as math 403 (or other 400 number).

**Math 581X Numerical methods for differential equations**
(Dual-listed with existing MATH 481). (3-0) Cr. 3. S.
Prereq: MATH 265 and either MATH 266 or MATH 267; knowledge of a programming language

New Courses

These are courses that we anticipate that we will create at some point in the future, independent of the existence of the graduate certificate. We have applied for NSF funding that will allow us to develop these courses in time to offer them in the second year of the graduate certificate program. If the NSF funding is not secured, we anticipate creating these courses over the course of first four years of the graduate certificate program.

**Math 565X Introduction to mathematical modeling**
(Dual-listed with MATH 465X being developed). (3-0) Cr. 3. S.
Prereq: MATH 265 and either MATH 266 or MATH 267; Math 207 or 317
The course will develop skills in mathematical modeling through practical experience. Students will work in groups on specific projects involving real-life problems that are accessible to their existing mathematical backgrounds. In addition to the development of mathematical models, emphasis will be on the use of computational methods to investigate these models, and effective oral and written presentation of the results.

**Math 569X Introduction to discrete mathematics**
(Potentially dual-listed with MATH 469X) (3-0) Cr. 3. S.
Combinatorial counting, binomial theorem, estimates of factorial, inclusion-exclusion principle, permutations without fixed points, double counting, graphs, subgraphs, graph score, connectivity, triangle-free graphs, graph isomorphism, planar graphs, points in general position, H-polytope, V-polytope, cyclic polytope, Farkas lemma, linear programming and duality.
An essential part of the program will be mentoring. Students in the program will have faculty mentors and graduate student mentors for regular one-on-one meetings. A new professional development seminar will be created in the fall semester. The seminar will include activities such as guiding students in their application for graduate school, preparing them for GRE subject test in mathematics, and panel discussions with graduate students and faculty. In the spring, the students will attend MATH 592, which is a seminar, where faculty members talk about their research to first year graduate students.

The target number of students will be 5-15 students. Preference will be for 6-8 students in the first year, but the department is prepared to host up to 10 students the first year, and ultimately up to 15 students per year. The program is focused on groups underrepresented in mathematics.

The department will recruit students through many of the same channels that graduate students are currently being recruited for the Masters and PhD programs. These include attending conferences such as the Math Alliance’s Field of Dreams conference, the national conference for the Society for the Advancement of Chicanos and Native Americans in the Sciences (SACNAS), the National Association of Mathematicians Undergraduate Mathfest, and the Joint Mathematics Meetings, as well as continuing to build relationships and a network with faculty at Historically Black Colleges and Universities, and Hispanic Serving Institutions. New alliances will be formed with the ISU Veterans Center, and various military institutions.

Among goals of the program is to have at least 3 students enter into the ISU PhD program in mathematics. For the students who do not continue studying mathematics at ISU, it will be considered a success if the student is accepted to and enrolls into another graduate program or has a job within a reasonable amount of time after finishing the program.

7. **Graduate certificate requirements including:**

   a. Admission standards and prerequisites for the certificate program.
      - Completed undergraduate degree in mathematics or closely related field.
      - Minimum GPA of 3.0.
      - Transcript.
      - Statement.
      - Two letters of recommendation.

   There is no GRE requirement. There are various studies and reports denouncing that GRE is a good predictor of success in graduate school. This includes a report by ETS (creator of the GRE) that acknowledges that critical skills associated with scholarly and professional competence aren’t measured by the GRE.

   Students will be able to apply directly to the Postbaccalaureate Certificate program. As with all other graduate programs in the Mathematics Department, the DOGE will counsel...
students that the Graduate Admissions Committee suggests reclassifying the application, if warranted. The decision as to which program the Graduate Admissions Committee recommends will be based on the applicant’s preparation and time (if any) between completion of the undergraduate degree and entering a graduate program.

b. Courses and seminars.
   - 13 credits total (12 graduate courses and 1 seminar credits)
   - 12 credits from MATH and STAT classes acceptable for graduate credit.
     - These 12 credits must including at least 9 credits chosen from MATH 501, MATH 503X, MATH 507, MATH 518X, MATH 565X, MATH 581X, MATH 569X, STAT 500.
     - The classes will be chosen to prepare the student for success in a doctoral program in mathematics or applied mathematics.
     - For mathematics, courses will normally include MATH 501 and MATH 503X and at least one of MATH 507, MATH 569X.
     - For applied mathematics, courses will normally include MATH 518X and MATH 581X and at least one of MATH 501, MATH 507.
   - Seminar classes
     - MATH 591 (0.5 credit, Orientation for Math. Graduate Students in the fall).
     - MATH 592 (0.5 credits Orientation for Math. Graduate Students in the spring)
   - GPA at least 3.00
   - A grade of C or better in every course

All 12 class credits earned while enrolled in the Postbaccalaureate Certificate in Mathematics Program may be transferred and become part of a program of study (POS) for a master or doctorate degree if accepted by the POS committee.

8. **General description of the resources currently available and future resource needs:**
   a. A list of supporting faculty members including a brief description of their expertise relating to the graduate certificate. All have extensive experience mentoring.

   Michael Young – Organizer of MOCA (Mathematicians of Color Alliance). Research in graph theory and combinatorics. PI of several grants to enhance the mathematical workforce. Lead organizer of this program.
   Leslie Hogben – Department’s Director of Diversity. Organizer of EDGE@ISU (mentoring cluster for women) and sponsor of Association for Women in Mathematics Student chapter being formed. Research in linear algebra, graph theory, and applications.
   Bernard Lidický – Provides international view to participants. Research in graph theory and computation.
   Henry Schenck – Department Chair. Army Veteran who created a mentoring program for veterans at Illinois and is creating one at ISU. Research in geometry, combinatorics, and computation.
James Rossmanith – Founded ISU SIAM chapter. Research in numerical analysis and applications.
Sung-Yell Song – Director of Graduate Education. Research in association schemes and graph theory.

b. The effects of any new courses on faculty workload.
   - MATH569X Discrete and MATH565X Modeling need faculty for developing and teaching them.
   - Advising by faculty will cost time but it does not count towards course workload.
   - Newly dual-listed courses have to be modified: Current MATH 302 will be revised and renumbered as MATH403 (to be dual listed with Math 503).
   - Mathematics Department has applied to NSF for funding that will include course buyouts for faculty to develop the new courses and support for postdoctoral associates to assist with mentoring and some of the teaching and course development.

c. Other resources required for the program including graduate assistants, laboratories and other facilities, supplies, etc.
   - Teaching Assistantships provided by the department (also for grading, help room,...)
     o The department hires a number of outside TAs to cover teaching needs.
       Outside TAs hired - S16 : 3, F16 : 13, S17 : 5, F17 : 4 (LAS has paid for TAs in Math to support (5) Meteorology Students.) In addition, temporary lecturers are teaching numerous recitations that could be taught by TAs.
       o The only time that assistantships are in short supply for Math/Applied Math PhD and MS students is in summer. We do not plan to fund the certificate students in the summer unless we receive the NSF grant we have applied for, which will provide such support.
   - Office space
     o The outside TAs are already provided with office space.
   - Travel funding
     o The Math Department will provide travel funds to the students in the same way it provides travel funds to degree seeking graduate students.
     o Proposal to NSF includes travel funding for the new students.
     o Recruiting would be done in conjunction with recruiting for graduate program, which is already funded. Proposal to NSF includes additional recruiting funds.
   - Graduate students as mentors
     o At the beginning of the program, current underrepresented students at the department will serve as mentors. Then the students who participated in the program and continue at ISU will become mentors.

9. Relationship of the proposed graduate certificate to the strategic plans of the department, college, and the university.
The program is actively supporting diversity in mathematics, which is one of the key values of the department and college. It will also improve the experience of underrepresented students, which is the first goal in the new ISU strategic plan.


Internal informal yearly review will be done at the end of each spring semester. Input to the review would be success of the participating students in doctoral or masters programs or the job market, their student records, and feedback from faculty, graduate mentors and participating students. The review will collect statistics and may result in changes to the program such as the selection of classes, content of the fall professional development seminar, mentoring guidelines for faculty as well as for graduate students, or recruiting practices. We plan to ask Prof. Ruth Haas for her input during the review.

ADDENDUM

Statement of support for Mathematics Department Chair Henry Schenck:

We have submitted a proposal to NSF DCL 17-078 “Improving and Supporting the Transition to Graduate School in the Mathematical Sciences” which would provide resources for the certificate program. In the event that the proposal is not funded, the department is currently working to implement an internal postdoctoral program, and will seek college/university support for the development of new classes.

NSF funding impacts the scale and timeframe for implementation; without funding the department will move forward, but at a more modest pace. The department is committed to searching for faculty who will serve as role models for underrepresented groups and also be capable of teaching the certificate classes/supervising research.