

3/24/2010

Dear David,

At the outset, let me apologize for making what has already been a prolonged proposal process, for a number of reasons, into an even longer one for you. I am writing in regard to the proposal from the Mathematics graduate program seeking the initiation of a new set of professionally oriented master's degree programs under the generic heading of the Master's of Mathematical Sciences (MMS). The proposal came to me in mid/late February and was given its initial review by the Graduate Council's Curriculum Committee in a timely fashion. Unfortunately, I have been unable to find the "quality time" necessary to report to you on the results of the Committee's initial vetting because of the perfect end-of-quarter storm which included the playing out of our Graduate Fellowship competition's nomination, vetting and awards processes and, uniquely this year, protracted meetings and tasks surrounding the ongoing semester conversion processes—with both of these "big" enterprises taking up most of my workdays of late. Finally, I am at the point where I can take the focused time to report to you what I should have been able to do a week or two ago. Again, my apologies.

Our Committee has reviewed your MMS proposal with the understanding that, at present, you seek approval for two specializations under that degree program heading, Mathematical Biosciences and Mathematics for Mathematics Educators. In the future, it is your intention to introduce additional track specializations under the same degree heading. The Committee is supportive, in principle, to this approach to rolling out the MMS degree plan but has some specific suggestions that it would like to see incorporated in a revised program submission. As soon as that revision can be submitted, the Committee will return to the proposal's processing during Spring Quarter. Given the relatively straightforward nature of the Committee's requests, I can envision the proposal being endorsed by the Committee and approved by the Graduate Council in the Spring, vetted and approved by CAA during the summer, and approved through the state's Regents Advisory Committee for Graduate Study (RACGS) processes during the Autumn quarter. I can easily envision the program being formally approved in time for enrolling students in Winter Quarter, 2011.

So, here goes—the requests and questions to be addressed in revising the proposal:

1. Please insert page numbers! (It is much easier to review a proposal and discuss it when precise references can be made to proposal pages and documentation.)
2. You presently have two "specializations" or "tracks" proposed for the umbrella degree program. Both would seem to be eligible for "transcript designations" within the Mathematics discipline under our policy for the inclusion of Graduate Specialization notations on transcripts if programs propose them and they are approved. In the context of the present proposal I believe there is sufficient documentation to get approval for such transcript designations for the asking in the Mathematical Biosciences and Mathematics for Math Educators tracks. If you want such Graduate Specializations offered with this degree, please add that to your request. As a practical matter, if you go that route, these students would still be earning the MMS degree. But on their transcripts there would be a notation indicating that they completed a Graduate Specialization in Mathematical Biosciences or Mathematics for Math Educators. As you develop and have additional tracks/specializations approved for the program, we can also approve, simultaneously, the additional transcript designation authorizations.

3. At present, the proposal is extremely repetitive, and goes back and forth between the two presently proposed specialization tracks while also spending considerable time and space with incompletely fleshed out descriptions of future tracks that are or will be under development. We think it important, especially for statewide approval of the umbrella degree approach, to indicate, by name, some of the tracks that you envision this degree offering in the future—but beyond the prospective track names, and an acknowledgement that each new track would, of necessity, be reviewed and approved through OSU's internal approval processes, I would remove all other references to and descriptions of the prospective tracks. For one, their incomplete state places focus on them and raises a number of questions about them that don't need to be on the table at present. More to the point, by including within the contours of the present proposal a plan for rolling out new tracks, and doing so in a manner that explicitly references the internal review they will go through, once the MMS is passed, we have successfully avoided the prospect of having to return to statewide review with every new track that you wish to develop. They will be purely internal matters—just as we have accomplished recently with the approval of an umbrella Specialized Master's of Business (SMB) degree in the Fisher College. Focusing on future tracks, in their incomplete state, would invite the state's graduate deans, unnecessarily, to want to see future more polished versions of them. Let's not go there...(These prospective tracks, by the way, all suggest the need for significant concurrence gathering—a discussion for another day...)
4. Once you eliminate the extraneous stuff on the future tracks (any detail beyond their prospective subject areas) please return to the two present tracks and discuss them in full detail rather than as, at present, going back and forth between them. The present approach ends up being quite repetitive and confusing. Really, the Committee sees this as a situation where everything is already presently in the proposal. What they seek, literally, is an integrative cutting and pasting that will make for a tighter, more coherent presentation of the two presently proposed degree tracks.
5. Given the restructuring of your Division and the former colleges, David is the perfectly appropriate person to have overseen the vetting of this at the college(s) level and to have sent it forward to us, with his blessing, for review. At the same time, however, the Committee would like to have some documentation, along the lines of the Cheryl Achterberg letter, from the Biological side of the Division—perhaps a note of support from Rich Hall? Or somebody with whom the Mathematical Biosciences track will be interfacing from that part of the Division?
6. In Proposal Point #7 on Performance Assessment, there is mention of the MS. Degree two times. I think that is language from an earlier drafting of this proposal and it needs to be removed and altered.
7. There was some confusion and some concern raised by the Committee surrounding the credit requirements for the proposal as well as some specific required features.
 - a. The proposal's body speaks to the requirement of student "projects of intermediate length, roughly three months, for the MMS students." Later, in the specific course requirement appendix, it indicates that the students will be completing Master's theses and undergoing a defense of the thesis along the lines of a traditional master's degree. Are these two separate requirements, or the same one? If the same, is it the "lesser" requirement spelled out in the proposal's body, or the thesis requirement as stated in

the appendix? In either/both cases, shouldn't the students be enrolled in some kind of thesis research or independent study course work? Clearly, they will be utilizing university resources and faculty time warranting the enrollment in a crediting course of some kind. And, once such credits are added, shouldn't the credit hour requirement for the degree be raised to reflect the project/thesis hours?

b. Relatedly, there is also a reference to internship possibilities for program students. Is the internship a required part of the program or only to be pursued by some students? This was a bit unclear in the proposal. And, for students pursuing such an internship, should they not be enrolled for course credit for their work which, presumably, will still necessitate OSU faculty involvement and oversight? And, once that work is accounted for, should this not also add to the total credit hours required for the degree?

8. One Committee member had a "just curious" question which is why I have placed it last. They asked whether the projected new Topology courses (640, 642) exist and are currently taught at higher level. Again, "just curious."

Again, Dave, I wish to emphasize that there was generalized support for your proposal, subject only to the need to get answers and revisions responsive to the questions outlined above. For my part, I don't think there is anything here that appears too daunting. I think that by responding to these requests successfully, the proposals will have a good deal smoother sailing ahead in the internal OSU processes to follow, specifically that conducted by CAA, and the statewide review processes as conducted through RACGS. Please don't hesitate to contact me with any questions and concerns as you work through this and, again, apologies for my not finding the time to get these thoughts to you a bit sooner.

All best,
Elliot

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4/28/10

Dear David,

The Curriculum Committee of the Graduate Council has now had a chance to review your revised proposal submission for the development of a Master's of Mathematical Sciences (MMS) degree. The revised proposal has brought us a good deal closer to Committee endorsement and forwarding to the Graduate Council for an approval vote. There still remain some issues, however, that need to be attended to, as outlined below, prior to moving the proposal forward to the full Council. I am confident that, in addressing the remaining the concerns, you will be assuring a good deal smoother sailing in the remaining approval points in the process, most specifically, CAA and statewide RACGS review. Listed below are the Committee's remaining concerns and requests for revision.

1. On page 5, the Mathematics for Mathematics Educators section, please remove the phrase "was publicly announced in the fall of 2009" which only serves to confuse the issue of your seeking approval now (not then...).
2. On page 6's discussion of the Practical Experience, Research Experience and Mentoring for the Mathematics Educators is it your intention that the summer internships will be accomplished as

paid GTA positions in your department? If yes, please specify that—and we're fine. If no, we'll need a good deal more detail about the nature of the mentoring to be offered students that will make this different than a GTA position and not lead to concerns about this being utilization of unpaid "Volunteer TAs."

3. In that same section it is suggested that these internships will likely provide experiences that will serve as the basis for the students' Masters thesis. What mechanisms will be in place for those instances when the internships do not provide such an impetus for the Masters thesis.? How will the thesis pursuits of such students be facilitated?
4. On the bottom of page 6/top of page 7 please remove the section on the internship projects for the prospective financial mathematics specialization. That's a future concern and simply offers an unnecessary additional target in the present proposal.
5. On Page 11 (Recruitment and Retention) please change (bottom of first para) "with all four specializations in place" to "when all four specializations are in place..."
6. The most "serious" revisions that remain necessary are in Appendix A which still has considerable lack of clarity.
 - a. The "prologue" to the two tracks gives their common requirements which add up to 46 hours. Is the one hour of thesis preparation all that they will enroll for as "thesis hours?" Won't they be enrolled during their summer internships? And they need to be enrolled for three hours in their quarter's of thesis defense and graduation. The bottom line would seem to be a requirement of more than the 46 hours listed. Please clarify/revise as appropriate.
 - b. Forty hours of required coursework is listed for the Mathematical Biosciences track. Would it help under "Elective Courses" to add, parenthetically (2 classes for a minimum of 6 hours) or whatever is needed to get to your final total beyond forty-six?
 - c. The page 14 chart for the Mathematical Biosciences track needs some work. Shouldn't three hours of enrollment be shown for the Year Two summer (minimum required for thesis defense/graduation)
 - d. Similar issues are in the Mathematics Educators appendix listings. For one, the course numbers in the core EDU classes (the 802.xx series) don't match with what you have in the table where they appear as 801.xx classes. Which is correct?
 - e. Are thirty eight credit hours required or forty one? Math 654 is listed as an elective yet, in the table, it appears to be included as a required course. Please clarify. Assuming it is required we now have 41 hours and one elective showing in the table schedule. Isn't a second elective needed .
 - f. As in point "c" above please include the necessary enrollment requirement for second summer and, as well, any credit hours required for thesis/mentored teaching experience.

So, we're really close! The requested revisions in the text would appear to be pretty straightforward and easily attended to. While the Appendix has some greater needs, please be assured that getting this right now will save a good deal of time in the rest of the process to follow. Please don't hesitate to contact me with any questions or concerns. The Committee will return to reviewing your proposal as soon as these remaining issues are addressed in a newly revised proposal submission.

Best,
elliott

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5/6/10

Dear Dr. Clemens

I see no issues in terms of what you propose for students completing the MMS. I can't speak about the funding protocol per se, but what you outlined is a common occurrence as students work towards degree completion. Students apply to graduate and then find themselves not able to complete degree requirements by the respective deadlines, so they either move to "end of quarter" status, or reapply to graduate for a future quarter. Students do need to keep in mind that they must be enrolled for at least 3 graduate credits any quarter they apply to graduate.

Sincerely,
Tim

-----Original Message-----
From: Elliot Slotnick
Sent: Wednesday, May 05, 2010 3:20 PM
To: Herb Clemens
Cc: Thomas Kerler; Tim Watson; Elliot Slotnick
Subject: RE: Revision of math's MMS proposal

Thanks, Herb--Glad to hear that you are closing in on this...Let me ask Tim Watson, our Director of Graduation Services, to chime in on your questions. For my part, Numbers One and Three, per se, don't seem to create problems because your two year support of the students coming in is totally independent of their degree progression. Theoretically, you could enroll students with no support at all--and they could take whatever time doing the degree actually took them, within whatever limits your program's rules defined and imposed. Tim can comment further, particularly on Number Two regarding ongoing coursework completion and the timing of the thesis defense. Stay tuned...

Best,
Elliot

-----Original Message-----
From: Herb Clemens [mailto:clemens@math.ohio-state.edu]
Sent: Wednesday, May 05, 2010 1:54 PM
To: Elliot Slotnick
Cc: Thomas Kerler
Subject: Revision of math's MMS proposal

Dear Elliot,

We are near completion on the changes of our MMS proposal that you requested in your letter to David Goss last week. However we are stuck on one issue related to the degree requirements and timing. Namely, what we want is the following:

- 1) the student completes the program in the Spring Quarter of the second year,
- 2) the student can take remaining required coursework and 'defend' the Masters thesis during that (Spring) quarter,
- 3) If a student fails or does not complete a necessary course in the final (Spring) Quarter, or if the thesis is not accepted by the student's committee, the student does not graduate, our commitment ends, and the student must register (and pay) for subsequent quarters on their own in order to finish the degree.

Thomas Kerler is concerned that Graduate School rules, timing for filing for degrees, etc., make it impossible to establish 1)-3) above as the norms.

Could you give us your reading on this question?

Thanks,
Herb

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5/21/10

Dear Herb,

I write with the good news that we are “virtually there” with regard to the Curriculum Committee endorsing your program proposal for a Master’s of Mathematical Sciences (MMS) degree with two distinct tracks. Thanks so much for your careful attention to the most recent request for revisions. The Committee was quite satisfied with the changes made. Indeed, the only thing left to be attended to are a few minor corrections to the document which, with your approval and, if possible, I can make as edits to the last version of the proposal. (If I am unable to alter the document myself we will have to request a clean “final” revision.) Specifically:

- On page 6, para 2, it was felt that the word “mere” should be “emerged.” Is this correct?*
- On p.7’s discussion of “Opportunities for MMS for Mathematics Educators Degree-holders” should the second “for” be removed?
- In same section (midway) does/should the opportunity for Ph.D. students in the College of Education and Human Ecology be extended to the projected Ed.D and Ed.S. programs’ students? (Should it be asserted for Ph.D. students, Ed.D. students, and Ed.S. students or what combination thereof?)
- Page 9, Point 6, Interim Dean Matt Platz’s college affiliation needs to be corrected

*Committee members expressed great curiosity and disagreement about the existence and/or meaning of the word “mere.” It was found to exist (duh) and means **1.** Being nothing more than what is specified, **2.** Considered apart from anything else: **3.** A small pond of standing water or **4.** To purify or refine

If, indeed, one of these meanings was intended and the word is not “emerged” please let me know.

All best-and please let me know if I can (presuming that I actually can!) make these minor changes.

Elliot

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5/22/10

Dear Elliot,
I have made the changes you requested. On your third point, I reworded the paragraph slightly so that degree distinctions are not relevant--we want to be inclusive but emphasize the value for doctoral candidates in math ed.
Your fourth point no longer applies. We recently learned that we were not awarded the NSF grant so I had to remove that entire paragraph.
Let me know if there is a problem with any of these changes. And thanks very much for your help!
Best,
Herb

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5/23/10

Looks great, Herb—One more change that I wasn't able to make on the document...Subhead on Page 7 presently reads:

Opportunities for MMS for Mathematics Educators Degree- holders

Please remove second "For" to have it read:

Opportunities for MMS Mathematics Educators Degree- holders

Thanks,
elliot

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5/23/10

Dear Elliot,
I left the second 'for' in because to me it is important. Otherwise people will think this is a Masters degree in mathematics education, which it definitely is not. If you take the second 'for' out, I assure you that you will sooner or later have us petitioning to change the name of the degree. How about "Opportunities for degree-holders of the MMS for Mathematics Educators"? Please advise.
Herb

5/23/10

Ah, I understand your point. Your call, leave as is or change as you suggest. For my part the two "for"s sounds awkward. Just let me know...

Thanks,
Elliot

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5/24/10

Dear Curriculum Committee Members,

Dena is out all this week and, as I think you all know, there is no Curriculum Committee meeting scheduled for tomorrow. With any luck, we won't have to meet a week from tomorrow and can conduct any business on revised proposals through e-mail review.

Towards that end, attached is a revision of the Master's of Mathematical Sciences (MMS) degree program. I went back and forth with the proposers on a couple of things and, personally, think that we are now "there" with this, though it has been quite a ride. May I ask you all to do a final read through of it (it isn't very long) and let me know your thoughts? Anything else to change? Do you approve of it in its present form? If so, and you all respond in the affirmative, we'll get it in the June Graduate Council meeting for Theresa to bring forward. You can send your thoughts directly to me, copied to Dena.

Many thanks, in advance, to all.

Best,
Elliot

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7/9/10

Dear Herb,

Once again I must ask your forgiveness for unconscionably slow reporting back to you on the review processes on you Master's of Mathematical Sciences (MMS) proposal that has now gone through several iterations of revisions. The Curriculum Committee did revisit the proposal at its last meeting at the end of Spring Quarter but, regrettably, it has taken me until now to get their comments synthesized in this memo. Both the Graduate Council and CAA are continuing their work over the Summer, so we will be able to continue the processing this proposal and moving it towards OSU approval and statewide review processes. Please know that my tardiness, while inexcusable, should have no impact on what was going to be the earliest period for university and statewide review of your proposal under any processing schedule, the coming Fall quarter.

The proposal is now virtually ready for presentation to the Graduate Council with only the revisions outlined below to be attended to:

1. On page 3 there is the initial mention of the MBI by abbreviation only. Please spell out Mathematical Biosciences Institute here and, as well, say a bit about it. Once we go outside of

your college and the university people will not know anything about what it is and does. Addition of a short paragraph will do the trick.

2. On page 5, second paragraph there is mention of Autumn 2010 as the starting date. Since that is when final university and statewide review is likely to be in process you should change that. You can go with Winter 2011 if you think that mid-year admissions are a possibility. Your call.
3. On page 6, last paragraph please delete second (repetitive) reference to "small startups."
4. On page 7, first sentence, "Mathematical Biology" should be "Mathematical Biosciences."
5. Page 7's discussion of the MPC needs some clarification. Is the MPC really the Graduate Studies Committee (GSC) of the Mathematics graduate program or, alternatively, an organizational entity that will "report" in some fashion to the Mathematics program's GSC?
6. Relatedly, membership of the MPC is specified by the names of the individuals ready to serve, which is fine. More general discussion of the MPC should be added as well. What is the plan for its continuity. Will it always be comprised of 10 members? Are there specific criteria or qualifications for serving on the MPC?
7. The sample schedule in Appendix A includes Math 693 coursework. That appears to be credit for student internships/research over and above the required 45 hours. If that is the case (or whatever is the case) should be clarified.
8. Under General Requirements/Thesis Preparation there is an indication that "by the start of Fall quarter each student..." We believe that should be Fall quarter of the second year, right? Please clarify...
9. Finally, please note that on page 14 there is a listing of EDU 802.04 and page 15 lists EDU 802.03. Please correct the entry that is in error.

As you see, these are all very minor tweaks that are left to be attended to. These sorts of things always tend to emerge in the final committee read through once all of the "big" questions have been raised and addressed. Once you turn these revisions around and give me a clean electronic copy of the proposal it will be sent quickly to the Graduate Council for electronic endorsement. There will be no necessity for any further review by our Curriculum Committee but, rather, only my eyeballing of the final changes that you have made.

Thanks for the grace and patience with which you and your colleagues have worked with me during the past months.

Best,
Elliot

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7/16/10

Dear Elliot,

Attached is the revised proposal incorporating the changes you requested. On your question 7, I have added an explanatory sentence (in italics in General Degree requirements). Namely, while reading hours (such as Math 693 and 999 hours) do count in the Graduate School's eyes as Masters credit, they do not count toward the 45 hour minimum total of coursework required by the Department for the MMS programs.

Let me know if you need anything else attended to or if I misinterpreted any of your requests.

Thanks and best,

Herb

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8/3/10

TO: 2009-2010 Graduate Council Members:

Dean Osmer asked me to send you the attached proposal to develop a Masters in Mathematical Sciences (MMS) degree program. The proposal has been endorsed by the Curriculum Committee and needs to be approved by the Graduate Council so that it can be moved through the review process.

Please send your approval/disapproval of the proposal to me as soon as possible or by 5 p.m. on Thursday, August 19, so that the proposal can be sent to the Council on Academic Affairs for further review. Alternatively, please send me any additional comments you may have about the proposal so they can be addressed.

_____ I approve of the proposed Master's Degree Program in Mathematical Sciences (MMS).

_____ I do not approve of the proposed degree. The proposal needs the following changes:

Please let me know if you have any questions.

Thank you.

Susan Reeser – 247-7413

Graduate School

Reeser.1@osu.edu

From: [Susan Reeser](#)
To: [Elliot Slotnick](#)
Cc: [Dena Myers](#)
Subject: Graduate Council approves proposal to develop a Master's Degree Program in Mathematical Sciences (MMS)
Date: Tuesday, August 17, 2010 10:08:38 AM
Attachments: [MMS Proposal 7_16_2010.pdf](#)

Dear Elliot:

I'm writing to let you know that I have received seven (7) responses to the e-mail below approving the proposal to develop a Master's Degree Program in Mathematical Sciences (MMS).

The seven Council members who approved the proposal are: Enrico Bonello, Theresa Early, Robert Perry, Jim Phelan, Harald Vaessin, Ingrid Werner, and Karla Zadnik.

I did not receive a response from Ana Azevedo, Ginny Bumgardner, Margaret Newell, Melissah Pawlikowski, Ruth Peterson, or John Sheridan.

I'll let you know if I receive any additional responses.

Susan Reeser

From: Susan Reeser
Sent: Tuesday, August 03, 2010 9:45 AM
To: 'ANA CLARA AZEVEDO'; Enrico Bonello; Ginny Bumgardner; Theresa Early; Margaret Newell; Melissah Pawlikowski; 'perry.6@osu.edu'; 'Ruth Peterson'; James Phelan; John Sheridan; Harald Vaessin; 'Werner, Ingrid'; 'Zadnik, Karla'; Roberto Rojas-Teran
Cc: Patrick Osmer; Ann Salimbene; Elliot Slotnick; Kathleen Wallace; 'Jonathan Nutt'; 'Laura.Smith2@osumc.edu'; Dena Myers
Subject: Vote needed on proposal to develop a Master's Degree Program in Mathematical Sciences (MMS)

TO: 2009-2010 Graduate Council Members:

Dean Osmer asked me to send you the attached proposal to develop a Masters in Mathematical Sciences (MMS) degree program. The proposal has been endorsed by the Curriculum Committee and needs to be approved by the Graduate Council so that it can be moved through the review process.

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Please let me know if you have any questions.

Thank you.

Susan Reeser – 247-7413
Graduate School
Reeser.1@osu.edu

On Jul 9, 2010, at 4:38 PM, Elliot Slotnick wrote:

Dear Herb,

Once again I must ask your forgiveness for unconscionably slow reporting back to you on the review processes on you Master's of Mathematical Sciences (MMS) proposal that has now gone through several iterations of revisions. The Curriculum Committee did revisit the proposal at its last meeting at the end of Spring Quarter but, regrettably, it has taken me until now to get their comments synthesized in this memo. Both the Graduate Council and CAA are continuing their work over the Summer, so we will be able to continue the processing this proposal and moving it towards OSU approval and statewide review processes. Please know that my tardiness, while inexcusable, should have no impact on what was going to be the earliest period for university and statewide review of your proposal under any processing schedule, the coming Fall quarter.

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The sample schedule in Appendix A includes Math 693 coursework. That appears to be credit for student internships/research over and above the required 45 hours. If that is the case (or whatever is the case) should be clarified.

Under General Requirements/Thesis Preparation there is an indication that "by the start of Fall quarter each student..." We believe that should be Fall quarter of the second year, right? Please clarify...

Finally, please note that on page 14 there is a listing of EDU 802.04 and page 15 lists EDU 802.03. Please correct the entry that is in error.

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Thanks for the grace and patience with which you and your colleagues have worked with me during the past months.

Best,
elliott

Program Development Plan

for a

Masters in Mathematical Sciences (MMS)

Department of Mathematics, The Ohio State University

Program director: Professor Avner Friedman, Chair of MMS Program Committee

Summary

The purpose of the Masters degree in Mathematical Sciences (MMS) is to build on the increasing importance of interdisciplinary fields, especially those combining quantitative skills with other sectors of natural and social sciences, to better prepare students for rewarding STEM careers.

The OSU Mathematics Department is proposing to develop a new Master's Program to train students in interdisciplinary areas that use mathematical, statistical or computational sciences. Initially there will be two specializations, Mathematical Biosciences and Mathematics for Mathematics Educators. We contemplate other specialization such as Financial Mathematics and Computational Mathematics in the future.

Each student will be exposed to the rigorous elements of a true post-graduate degree, including interdisciplinary coursework, a practical research project or internship with one or more mentors of multiple skills, and composition of a research Master's thesis based on that research experience.

Master's theses will be based on and developed from the student's summer internship experience. Theses are expected to include advances in research and discovery and the output of the program will be disseminated via the web and via presentations at professional meetings.

More broadly, the proposed MMS program will train an expanding corps of mathematics post-graduates in areas of importance to the Ohio and national workforce. This will be accomplished by exposing students to both academic and professional/industrial settings, and preparing them to make professional contributions in those settings.

An additional benefit of the MMS program that we anticipate is the enhanced participation of underrepresented groups in the mathematical sciences in Ohio. Our efforts will be supported by several offices on campus devoted to diversity recruitment such as the OSU Office of Minority Affairs, the Graduate School Recruitment and Diversity Initiatives, and the MPS College Assistant Dean for Diversity. (See letter of support from Dr. Rose Wilson-Hill, OSU Director of Administration/Special Programs in the Supplementary Documentation section at the end of this proposal.)

Program Description

1. Vision and goals

The vision driving this MMS Program is to build on the increasing importance of interdisciplinary fields, especially those combining quantitative skills with other sectors of natural and social sciences, to better prepare students for rewarding STEM careers. We emphasize interdisciplinarity because of its growing role in both education and research. Just as the modern research team is characterized by multiple partners with complementary skills, so the individual researcher and teacher can increase effectiveness through fluency in more than a single specialty.

Some of the fastest-growing aspects of the life sciences, for example, are those with mathematical components, such as bioinformatics and disease modeling. As young people read and hear about the growing role of simulations, data manipulation, and other quantitative skills in many knowledge-intensive activities, they are inspired by the potential for exciting careers in these areas. At the same time, there is growing demand by employers for graduates who have combined mathematics with programs in education, finance, computation, and other fields. This trend is seen in every sector, including education, industry, government, and non-profit institutions.[1]

Institutions that prepare the next generation of scientists and engineers must design programs capable of meeting these professional and career challenges. The design of a regular PhD degree program, which expects its students to focus deeply and narrowly on a single theoretical discipline, is patently inappropriate for a program of study with a broader and more vocational orientation. Moreover, the population of applicants and students seeking careers in the aforementioned professions is distinctly different from those who aspire to enter academic careers and pursue a PhD or regular MS degree in core mathematics.

Thus in order to effectively meet the educational demands of professionally orientated students seeking Masters degrees in interdisciplinary mathematical sciences it is imperative that an infrastructure and curriculum is created that is separate from the one for the existing PhD and MS degrees at our department. The department is strongly committed to establishing a new MMS degree for this purpose.

This commitment is also reflected in the department's Strategic Plan which has earmarked 40-50 GTA positions to support future MMS students. In turn the number of GTA positions available for the PhD program will be reduced from about 130 to 80-90 over the course of the next three years.

Strengthening the role of the master's degree

We suggest returning the element of “mastery” to the master’s degree in mathematics so that it plays a central role in Ohio and national graduate education for many career paths, including teaching at secondary and tertiary levels, clinical practice, many positions in the private and public sectors, and preparation for additional training and research.

The current model under development at Ohio State University's Department of Mathematics will seek to enhance the skills of the mathematics student by expanding the choices among career opportunities. The Department has developed a plan of interdisciplinary specializations that are designed to add complementary skills in related fields. We initially propose two specializations, Mathematical Biosciences and Mathematics for Mathematics Educators. *We request that the two specializations "Mathematical Biosciences" and "Mathematics for Mathematics Educators" be officially designated as Graduate Specialization with appropriate transcript designation.* We contemplate the addition of two other specializations in the future, Mathematics of Finance and Computational Science. We will seek official approval of these specializations, with appropriate transcript designation, as they are developed.

In addition, the Department will emphasize complementary "career skills," such as communication and teaching, that are further enhanced by multiple mentoring and internships. Such skills and experiences have been identified as integral to career success and in need of greater emphasis by graduate programs[2]. For each of the specializations, students will be exposed to practical or research experiences that, like the educational component, will provide career development opportunities, develop personal as well as professional skills, develop the ability to work in teams, and provide access to mentors in more than one discipline.

2. Mathematical Biosciences Specialization

Rationale for a Mathematical Biosciences Specialization

Mathematical biology is the use of mathematics as a tool to answer biological questions. What mathematical biology does best is to translate biological concepts and hypotheses into highly structured, testable mathematical structures, or mathematical models. As recognized in previous reports, [5] progress at the interface between mathematics and biology has been hindered by the lack of appropriately trained scientists. Also, there is an urgent and widespread need for individuals who are at least conversant with both mathematics and biology. [6]

The Mathematical Bioscience specialization makes use of the unique availability of the National Science Foundation's Mathematical Biosciences Institute (MBI), located on the OSU Columbus campus, combined with eight regular faculty members in mathematical biology in OSU's Mathematics Department, a highly ranked research department. The MBI is one of seven NSF Mathematical Sciences Institutes. Its mission is to foster interaction between the mathematical and biological sciences. This puts the program in a position to compete with the most sought-after programs in the United States. It also assures that no other program in the State of Ohio is able to provide training in mathematical biology at a comparable level.

Mathematical Biosciences Program

This specialization has been proposed and designed by the Mathematics Department in collaboration with the MBI. For the schedule of courses comprising the program, see Appendix A.

The Mathematical Biosciences specialization will include comprehensive biology instruction for mathematicians who have never studied biology but who would like to bring their quantitative skills into this field. Beyond this instruction, students will also have opportunities to learn professional skills and to prepare for the work force.

In the spring of 2009, A. Friedman and C.-Y. Kao introduced a new course in mathematical biology that typifies the rich intellectual offerings of this track for MMS students as well as their opportunities for employment. The course is structured as a collection of case studies of interesting biological problems, such as enzyme dynamics, autoimmune diseases, cancer, wound healing, neurosystems, and plant growth. In each topic a problem is posed and a mathematical model and relevant mathematical methods developed. Students validate the model by simulating it and then comparing the numerical results with known experimental results. Once the model has been validated, students use it to propose new biological hypotheses. This approach not only helps develop mathematical and computational tools to address real-world problems but also decreases the need to rely on experiments.

Among the novel aspects of the MMS is its specially adapted sequence on differential equations developed by Janet Best, taught using examples from biology. These examples were chosen to be both relevant and interesting, at the same time making use of the “just-in-time” introduction of the necessary mathematics tools. These tools, over the trajectory of the three-quarter sequence add up to an integrated general mathematical theory of differential equations.

Practical Experience, Research Experience, and Mentoring

Students will develop personal and professional skills not only through courses but also through the three-month summer internship program, based on which their Masters thesis project will be developed. Internships will be arranged through the broad network of MBI contacts. Each student will be co-mentored by a biological and or mathematical scientist, and projects will be jointly chosen by the students and co-mentors. The students will also benefit by participating in the three-week MBI summer programs for graduate students, which also offer a set of projects and assistance from MBI postdoctorate fellows. Recent summer projects included biochemical reaction networks, mathematical modeling of immunity, microarray data analysis, primary visual cortex ocular dominance, and models of tumor growth.

We envision projects of intermediate length, roughly three months, for the MMS students. Each MBI project is co-mentored by one biologist and one mathematical scientist. The biologist mentors who work with the program have all expressed interest in mentoring the master's students.

The current mathematical mentors for MBI postdocs, Avner Friedman, Janet Best, Ching-Shan Chou, David Terman, Chiu-Yen Kao, Joseph Tien, Yuan Lou and Marty Golubitsky of the Mathematics Department, have all agreed to serve as mentors/advisors to the master's students .

3. The Mathematics for Educators Specialization

Rationale for a Specialization for Mathematics Educators

There is consensus among experts, as well as market evidence, that there is an unfulfilled need for professionals with mathematical formation and ability to communicate mathematics at a level appropriate for PhD programs in mathematics education, for mathematics instruction at community colleges, for mathematics specialists in school districts, for industrial employers, and for a host of other professional opportunities in our information society.

The Mathematics for Mathematics Educators Specialization is exactly designed to fill this need.

Mathematics for Mathematics Educators Program

This specialization is scheduled to be officially inaugurated in Winter 2011. Like the Mathematical Biosciences specialization, it is designed to add skills and perspective for students who have a bachelor's degree in mathematics and would like to gain both broader and deeper preparation for a career. (For the schedule of courses comprising the program, see Appendix A.)

Entrance requirement for the specialization is a strong undergraduate degree in mathematics. Central to the program is advanced training in core mathematics, including capstone courses in number theory, linear algebra, real analysis, as well as introductions to mathematical logic, topology and differential geometry. In addition, the sequence challenges prospective mathematics educators to think more deeply about their career. What is effective mathematics teaching, and, more generally, communication of mathematics in a variety of settings? How is teaching/communicating mathematics similar to and different from teaching other subjects? What skills and knowledge bases are needed for teaching mathematics? How can a teacher successfully reach all students?

A new course, required for this specialization, has been developed by the OSU mathematics education group and is devoted to exploring such questions and studying strategies, techniques, materials, technology, and current research used to teach mathematical concepts to school students. The participants will review the traditional and current standards in teaching mathematics, especially at 9-16 levels; develop awareness of the professional resources, materials, technology and information available to teachers; prepare unit and lesson plans with related assessment procedures on a variety of topics; and acquire teaching experience by taking part in individual tutoring, observation at a high school, and/or presenting lessons at the appropriate level.

Practical Experience, Research Experience, and Mentoring

For the specialization for mathematics educators, the summer internships will take place within the Mathematics Department itself. The MMS students will be awarded summer Graduate Teaching Assistantships on a competitive basis and assigned mentored summer teaching in sections of lower-division mathematics summer courses. These classes can themselves serve as resources for formative classroom effectiveness assessment, the design and execution of which could be the genesis of masters theses for some students. Herb Clemens and Azita Manourcheghri will help identify mentors for the students, and

strong support will be provided by Dean Cheryl Achterberg; see her letter in the Supplementary Documentation section at the end of this proposal.

If a thesis project does not emerge from the summer mentored teaching, the student is responsible for meeting with his/her advisor over the summer to formulate and begin the thesis project before the beginning of the program's second year.

Students in the specialization for mathematics educators will be able to gain plenty of practical experience in a wide variety of teaching settings as GTAs. The department offers a wide range of over 80 undergraduate courses, which are taken by several tens of thousands of undergraduate students. Within these offerings there are many very different classroom settings, including large coordinated lectures with recitations, small individual classes, classes taught in group or 'guided discovery' styles, as well as classes taught with extensive use of computers. In addition, the department offers coaching and support through teacher preparation courses in the summer as well as class visitations with instructor or coordinator feedback.

Students who do not compete successfully for summer GTA's will have to make their own alternative arrangements for mentored summer teaching. (It is expected that such cases will be rare--students in this specialty should be among our most capable teachers.)

4. Measuring Outcome and Employment Opportunities

The success of the MMS program will be measured by the quality of subsequent employment and/or professional trajectory of the graduates.

A central objective of the program is to lay the groundwork for employment. This means preparing students to succeed not only at a technical level, but at meeting the general needs of the workplace, whether in a high school, community college, government lab, nonprofit, or private firm. The workplace today is more interdisciplinary, interactive, and international than in the past, and demands more collaboration, flexibility, and ability to communicate with colleagues in multiple fields. Systems biology, for example, needs mathematicians who can work with chemists, physicists, statisticians, and computer scientists.

Opportunities for Mathematical Biosciences MMS Degree-holders

Students will be trained in modeling, statistics, computation, and general problem solving; they will also gain skills of value not only in secondary and tertiary teaching, but also in planning organizations, consulting, public health organizations, pharmaceuticals and biotech, governments, and small startups. Ohio is not a national leader in biologically-based industries, but there are adequate potential employers for MMS graduates, including firms in Dublin (Cardinal Health); Athens (Diagnostic Hybrids), Cincinnati (Barr Pharmaceuticals and Kendle International), Cleveland (ChanTest), Bedford (Ben Venue Laboratories), Newark (Bayer), Mayfield Heights (DataTRAK), and Wilmington (Alkermes). There is even greater demand for fully prepared teachers, and it is expected

that many graduates of the MMS will make their contributions in junior colleges, secondary schools, and other teaching environments.

The MMS specialization in mathematical biosciences will build on relations developed over the years between the MBI and its corporate sponsors and visitors. It will also continue its special relationship with Battelle Memorial Institute in Columbus, which supports many bioscience-based projects.

Graduates of the MMS specialization are also likely to find employment at the federal level in organizations such as the Centers for Disease Control, where math-bio skills are needed for modeling the spread of diseases, the National Security Agency, which employs a large workforce of mathematicians, and in the Department of Homeland Security, which studies a range of bio-related threats, immunities, and responses.

Opportunities for holders of the MMS for Mathematics Educators degree

Graduates of this program will be exceptionally well prepared for teaching at many levels. As anyone in the field will attest, the most sought-after mathematics educators are those who also have advanced understanding of mathematics. These mathematics educators have a wider range of professional skills in teaching and research of direct benefit to the universities, agencies or corporations that hire them. Additionally, these professional educators will be desirable as community college teachers and to school districts where they will also be qualified not only to teach at higher levels but also to help deliver mathematics-based professional development to their colleagues and districts; see letter of support from Dean Cheryl Acherberg in Supplementary Documentation. In particular, the post-doctorate professional opportunities for doctoral students in mathematics education in the College of Education and Human Ecology at Ohio State University will be considerably enhanced if they also hold a master's degree in mathematics. Finally, government and many industries in our technological economy seek mathematically well-trained personnel who have effective communication skills and the ability to manage enterprises grounded in aspects of the mathematical sciences. This master's degree provides the necessary base of advanced mathematical training and emphasis on communication to succeed in many careers that demand both.

5. Organization and management

Our plans for program organization and management include the use of formal mechanisms to ensure fair allocation of MMS resources and to enable faculty members, students, and visitors to interact effectively. The individuals listed just below will form the MMS Program Committee (MPC) that will oversee the long-term development of the program and its specializations. The MPC will also meet quarterly (or more frequently as needed) to review courses and content, student progress in coursework and internships, the applications process and to review dissemination plans. The MPC will report to the Department's Graduate Studies Committee and be considered as operating within the GSC's overall mandate. The MPC will be made up of 5-10 members, representing the various specializations and constituencies involved in the MMS.

Initial composition of the MMS program committee (MPC)

Avner Friedman, Department of Mathematics

Role: Friedman will work with biologists to provide internship projects to students in the mathematical biology program, and will co-mentor them. He will also work on the development of the Specialization in Financial Mathematics.

Herb Clemens, Department of Mathematics

Role: Clemens chairs the OSU Mathematics Graduate Studies Committee. This committee is responsible for the configuration and oversight of the new graduate programs.

Doug Wolfe, Department of Statistics

Role: Wolfe will oversee the required and elective courses in the Department of Statistics for students in the mathematical biology specialization; he will also work with companies to provide internship projects for students in this program.

Chiu-Yen Kao, Department of Mathematics

Role: C.-Y. Kao will oversee the numerical analysis courses; she will mentor students doing internship, and oversee development of an eventual specialization in computational mathematics.

Thomas Kerler, Department of Mathematics

Role: Thomas Kerler will oversee the following aspects: recruitment, admission, and advertisement, including efforts regarding traditional underrepresented groups

Erich Grotewold, Department of Molecular Biology

Role: E. Grotewold has developed and is teaching a comprehensive biology course, which will prepare the math biology students for internships and future experience in the math-biology field. He will help with internship projects.

Azita Manouchehri, School of Teaching and Learning.

Role: A. Manouchehri will teach courses in the mathematics education program and will help provide the students internship experience in teaching curriculum development.

Janet Best, Department of Mathematics

Role: J. Best will work with students to prepare them so that they benefit from colloquium and seminar talks at the MBI. She will also help in mentoring them in their internship projects.

Chunsheng Ban, Department of Mathematics

Role: C. Ban will assist in the development of an eventual specialization in financial mathematics. He will also help find summer internships for students.

Greg Baker, Department of Mathematics

Role: Prof. Baker has developed courses in computational science at several institutions. He will work closely with other members of the Department of Mathematics at Ohio State University to develop new courses appropriate for Master's level students. He will include faculty in the College of Engineering and the College of Mathematical and Physical Sciences to provide advice and suggestions for the program. Specifically, appropriate course in other associated departments will be included as electives.

6. Further Institutional Commitments

As mentioned in the introduction the Department is committed in its Strategic Plan to bifurcate 30%-40% of its available Graduate Teaching Assistantship positions from the PhD program to the MMS program in order to support students with adequate stipends, tuition, and office space. This constitutes the essence of the required financial commitment since no additional laboratory spaces or other equipment are required.

Cheryl Achterberg, the Dean of the College of Education and Human Ecology, has committed faculty resources of the college's Mathematics Education group to teach the three-course sequence in teaching and learning that will be required for all mathematics MMS students pursuing the track for mathematics educators. Anita Hopper, the Chair of the Department of Molecular Genetics, committed to have her faculty teach the new comprehensive biology course. Letters of support and commitment from the two for the respective specializations are attached as at the end of this proposal.

The MMS Program is an official part of the Strategic Plan of the Mathematics Department. In addition we anticipate applying for recognition of most of the proposed specializations as Professional Science Master Programs with the Council of Graduate Schools in the future. This will occur as each of these specializations has established itself over the course of a few years. This long-term goal is reflected also in the Strategic Plan of the Department.

7. Performance Assessment/Project Evaluation

Professors Friedman, Clemens and Kerler will comprise an *ad hoc* committee to evaluate the program's success in meeting its goals for **students**.

Key Evaluation Questions:

- What students apply for and are accepted to the program?
- Does the program attract: Students with strong mathematics backgrounds? Students from traditionally under-represented groups?
- Do entering students make adequate academic progress in the first year of the program?
 - Do students participate in summer research projects/internships?
 - Do students successfully complete the program?
 - Do students find employment in their field of study and/or enroll in advanced study?

Benchmark measures

- 1 of each cohort of 6 entering students be a member of a traditionally under-represented group
- an additional 2 of each cohort of 6 entering students be female
- all 6 of each entering cohort have a strong undergraduate degree in mathematics (or equivalent mathematical level)
- all 6 of each entering cohort have an internship in the summer between the first and second years of the MMS program

- 5 of the 6 in each entering cohort complete the MMS degree within 2 years and find opportunities in fields for which they trained and/or in a STEM-related program of advanced study.

An annual report assessing the progress of the MMS will be submitted to the Mathematics Department Chair and the Dean of the Graduate School.

8. Recruitment and retention

National studies have found that students from all over the country are eager for this kind of formation and experience. However, at the outset we can accept only a small number due to the Department's limited funding. As with most universities, our TA funding is intended primarily for doctoral students. We hope to be able to recruit larger numbers in future years as the value of the program becomes well known and financial support increases. Following the current Strategic Plan we plan to recruit around 6 students per year and per specialization. That is, when all four specializations are in place the incoming MMS will be 20-25 students strong. These numbers will be phased in over the coming three years as further specializations are introduced.

An important aspect of recruitment is our desire to solicit applications from underrepresented groups, including native American, African American, Hispanic, Alaskan native, disabled, and female students, whose talents this institution and nation cannot afford to neglect. At the outset, the program will consult with a Diversity Committee that was established last year by the MBI explicitly for this purpose. For example, Professor Avner Friedman (former director of the MBI) is currently mentoring one graduate student and one postdoc from Africa as part of the MBI-DIMACS project supported by the NSF.

The vice-chair of graduate studies (Thomas Kerler) will be in charge of recruitment, and will travel to various institutions to advertise our program and talk to students. Destinations include the annual SACNAS conference for Hispanics and Native American science students (with heavy emphasis on interactions with life sciences), nationally ranked postsecondary minority serving institution or institutions with high minority representation (particularly in the Southwest and the Carolinas), traditional all-female colleges (such as Seven Sisters), but especially also Ohio destinations for underrepresented groups such as the SUMSRI conference at Miami University (Oxford), Wilberforce University, and several other institutions particularly in northern Ohio. In addition the annual Young Mathematicians Conference at the department, a competitive national undergraduate research conference in mathematics (organized by Thomas Kerler), attracts substantial numbers of highly talented student from traditionally underrepresented groups among its 70-75 participants. Thus this venue provides another effective method of mining for such students and advertising our program to them while they are visiting the Department.

As with our dissemination plan, we will invite for visits key faculty from undergraduate institutions from which we hope to recruit qualified students. A particular effort will be made to invite faculty from institutions with student majorities from traditionally

underrepresented groups. Our College Associate Dean for Diversity, Oludurotimi Adetunji, has already begun to aid us in this effort through his network of connections with historically black colleges. Additionally we are working with the OSU Office of Minority Affairs and its Director, Professor Rose A. Wilson-Hill. (See her letter in the Supplementary Documentation section at the end of this proposal.)

As for retention, we believe that features of the program itself will promote high student retention. Both the interdisciplinary design of the education and research, which students actively seek, and the numerous opportunities for mentoring, career planning, and working in diverse teams will stimulate interest and accelerate the learning process in ways that are both challenging and realistic. We expect that our wide and expanding network of professors, advanced students, and private-sector leaders will be available to address student needs promptly and directly, both with respect to academic issues and plans for employment.

C. References Cited

- [1] [Facilitating Interdisciplinary Research](#), Washington, DC: National Academic Press, 2004.
- [2] *Careers in Science and Engineering: A Student Planning Guide to Grad School and Beyond*, CUSEUP, Washington D.C., National Academic Press, (1996).
- [3] *Reshaping the Graduate Education of Scientists and Engineers* (1995).
- [4] *On Being a Scientist: Responsible Conduct in Research* (1995).
- [5] Hastings, A. and M. A. Palmer (2003), Mathematics and biology: A bright future for biologists and mathematicians? *Science* 299 (5615): 2003-2004.
- [6] The Case for an Institute of Mathematical Biology," Report from an NSF-funded workshop, Washington DC, Sept. 18-20, 2006; sponsored by the NSF through grant Number DEB-0640021 to the University of California at Davis.

Appendix A

Course and Graduation Requirements for initial MMS specializations

1. GENERAL REQUIREMENTS

- a) **Course Work:** Each specialization has a list of *Required Courses* and *Elective Courses* as listed below. Students must take and pass all required courses, as well as a minimum of two elective courses. The total credits earned from required and elective courses must be at least 45 hours. *Reading hours (e.g. Math 693, Math 999), while they do count toward the 45 hours required by the Graduate School for the Masters degree, do not count toward the 45 hours required by the MMS programs.*
- b) **Internships:** Each student participates in an internship during the summer quarter between the first and second year. Internships are individually arranged and approved by the advisor and the chair of the MMS committee. A student may receive between 1 and 5 hours of credit for the internship. These hours do *not* count towards the required course work above.
- c) **Thesis Preparation:** By the start of the fall quarter of the second program year each student must have elected a thesis advisor and must remain enrolled for a minimum of one credit of Math 999 each quarter with this advisor until graduation. (The Math 999 credits do *not* count towards the course work above). The thesis advisor needs to be an M-status faculty of the mathematics department.
- d) **Master's Thesis and Committee:** The thesis will be written during the second year under the supervision of the thesis advisor, and prepared in compliance with university rules. The thesis writing should be completed early during the spring quarter. By the beginning of the spring quarter a student should have elected also the second thesis committee member, who may be M-status faculty from another department related to the specialization.
- e) **Graduation and Defense:** All students are expected to apply to graduate at the beginning of the spring quarter of their second year. The thesis should be submitted and the oral exam completed during the same spring quarter. There is no written part for the MS examination. Required coursework for the spring needs to be completed satisfactorily in order to graduate, regardless of passing the examination.

2. CURRICULUM FOR SPECIALIZATION IN MATHEMATICAL BIOSCIENCES

Required Courses [40 hours]

MATHEMATICS

- Math 615 (3 cr. hrs.) Applied Differential Equations I
- Math 616 (3 cr. hrs.) Applied Differential Equations II
- Math 617 (3 cr. hrs.) Applied Differential Equations III
- Math 607 (5 cr. hrs.) Essentials of Numerical Analysis
- Math 606 (3 cr. hrs.) Introduction to Numerical Analysis of Partial Differential Equations

- Math 865 (3 cr. hrs.) Modeling in Mathematical Biology
- MOLECULAR GENETICS
- MOL GEN 660 (5 cr. hrs.) Integrated molecular and cellular biology for non-biologists I
 - MOL GEN 661 (5 cr. hrs.) Integrated molecular and cellular biology for non-biologists II
- STATISTICS
- Stat 610 (5 cr. hrs.) Probability for Statistical Inference
 - Stat 623 (5 cr. hrs.) Theory of Statistical Analysis

Elective Courses [elect at least two courses from those below for a minimum of 5 hours]

- BIOCHEMISTRY
- BIOCHEM 613 (4 cr. hrs.) Biochemistry and Molecular Biology I
 - BIOCHEM 614 (4 cr. hrs.) Biochemistry and Molecular Biology II
 - BIOCHEM 615 (4 cr. hrs.) Biochemistry and Molecular Biology IIIBME

- BIOMEDICAL
- BIOMEDE 600 (3 cr. hrs.) Survey of Biomedical Engineering

- ECOLOGY
- EEOB 617 (5 cr. hrs.) Theoretical Ecology I
 - EEOB 714.01 (4 cr hrs) Theoretical Ecology II: Lecture
 - EEOB 714.02 (2 cr. hrs.) Theoretical Ecology II: Lab
 - EEOB 880 (1 cr. hr.) Grad student seminar

- MOLECULAR GENETICS
- MOLGEN 605 (4 cr. hrs.) Molecular Genetics I
 - MOLGEN 606 (4 cr. hrs.) Molecular Genetics II
 - MOLGEN 607 (3 cr. hrs.) Cell Biology
 - MOLGEN 608 (3 cr. hrs.) Genes and Development
 - MOLGEN 640 (5 cr. hrs.) The Genetic Basis of Evolution
 - MOLGEN 700 (3 cr. hrs.) Systems of Genetic Analysis
 - MOLGEN 701 (3 cr. hrs.) Molecular Genetics: DNA Transactions

- PLANT AND MOLECULAR BIOLOGY
- PCMB 622 (4 cr. hrs.) Plant Molecular Biology
 - PCMB 623 (4 cr. hrs) Plant Genetics and Genomics
 - PCMB 630 (3 cr. hrs) Plant Physiology I
 - PCMB 631 (3 cr. hrs.) Plant Physiology II

- STATISTICS
- Stat 632 (3 cr. hrs.) Applied stochastic processes I
 - Stat 628 (4 cr. hrs.) Statistical practice I (Statistical computing)
 - Stat 694 (2-5 cr. hrs.) Topics in Mathematical Statistics
 - Stat 694 (2-5 cr. hrs.) Statistical Methods for Analyzing Genetic Data

- MATHEMATICS
- Math 715 (3 cr. hrs.) Differential Equations I (ODE)
 - Math 716 (3 cr. hrs.) Differential Equations II (PDE)
 - Math 707 (3 cr. hrs.) Numerical Methods in Scientific Computing I

- Math 601 (3 cr. hrs.) Mathematical Principles in Science I (Abstract Linear Algebra)
- Math 602 (3 cr. hrs.) Mathematical Principles in Science II (Abstract Linear Algebra)
- Math 651 (5 cr. hrs.) Introduction to Real Analysis I
- Math 652 (5 cr. hrs.) Introduction to Real Analysis II
- Math 722 (3 cr. hrs.) Theory of Probability I
- Math 723 (3 cr. hrs.) Theory of Probability II
- Math 724 (3 cr. hrs.) Theory of Probability III

Sample schedule for math biology specialization (NB: MMS course hours total to one hour over minimum required)

Year	Quarter	Courses			MMS Course hrs	MMS Res/Int hrs
Year 1	<i>Autumn</i>	Math 615 (3 cr)	MOLGEN 660 (5 cr)	Math 693 (1hr)	8	1
	<i>Winter</i>	Math 616 (3 cr)	MOLGEN 661 (5 cr)	Math 693 (1hr)	8	1
	<i>Spring</i>	Math 617 (3 cr)	Math 606 (3 cr)	Elective (3 cr)	9	
	<i>Summer</i>	Internship (Lab/Project Work) (5 hr)				7
Year 2	<i>Autumn</i>	Stat 610 (5 cr)	Elective (3 cr)	Math 999 (1 hr)	8	1
	<i>Winter</i>	Math 607 (5 cr)	Stat 623 (5 cr)	Math 999 (1 hr)	10	1
	<i>Spring</i>	Math 865 (3 cr)		Math 999 (6 hr)	3	6
Total					46	17

3. CURRICULUM FOR SPECIALIZATION FOR MATHEMATICS EDUCATORS

Required courses [38 hours]

- Math 601 (3 cr. hrs.) Mathematical Principles in Science I (Abstract Linear Algebra)
- Math 602 (3 cr. hrs.) Mathematical Principles in Science II (Abstract Linear Algebra)
- Math 683 (4 cr. hrs.) Topics in number theory and algebra
- Math 651 (5 cr. hrs.) Introduction to Real Analysis I
- Math 652 (5 cr. hrs.) Introduction to Real Analysis II
- Math 640 (3 cr. hrs.) Point-set Topology
- Math 641 (3 cr. hrs.) Combinatorial Topology
- Math 642 (3 cr. hrs.) Geometry of Curves and Surfaces
- EDU 802.01 (3 cr. hrs.) Representations (Connecting Secondary Mathematics to Higher Mathematics Topics)
- EDU 802.02 (3 cr. hrs.) Examples and Non-examples (Teaching Mathematics)
- EDU 802.04 (3 cr. hrs.) Problem Solving (Student Learning Processes in Mathematics)

Elective courses [elect at least two courses from those below for a minimum of 7 hours]

- Math 607 (5 cr. hrs.) Essentials of Numerical Analysis

- Math 606 (3 cr. hrs.) Introduction to Numerical Analysis of Partial Differential Equations
- Math 615 (3 cr. hrs.) Applied Differential Equations I
- Math 616 (3 cr. hrs.) Applied Differential Equations II
- Math 617 (3 cr. hrs.) Applied Differential Equations III
- Math 647 (3 cr. hrs.) Set theory
- Math 648 (3 cr. hrs.) Mathematical Logic I
- Math 649 (3 cr. hrs.) Mathematical Logic II
- Math 654 (3 cr. hrs) Complex Variables
- Math 674 (4 cr. hrs) Survey of Combinatorial Mathematics

Sample schedule for specialization for mathematics educators (NB: MMS course hours total to two hours over minimum required)

Year	Quarter	Courses			MMS Course hrs	MMS Res/Int hrs
Year 1	<i>Autumn</i>	Math 601 (3 cr)	Math 651 (5 cr)	Math 693 (1hr)	8	1
	<i>Winter</i>	Math 602 (3 cr)	Math 652 (5 cr)	Math 693 (1hr)	8	1
	<i>Spring</i>	Math 683 (4 cr)	Elective (3 cr)	Elective (3 cr)	10	
	<i>Summer</i>	Internship (Mentored Teaching) (4 hrs)		Elective (3 cr)	3	4
Year 2	<i>Autumn</i>	Math 640 (3 cr)	EDU 802.01 (3 cr)	Math 999 (3 hr)	6	3
	<i>Winter</i>	Math 641 (3 cr)	EDU 802.02 (3 cr)	Math 999 (3 hr)	6	3
	<i>Spring</i>	Math 642 (3 cr)	EDU 802.04 (3 cr)	Math 999 (3 hr)	6	3
Total					47	15

Supplementary Documentation:



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April 1, 2010

Dr. David Goss, Chair
Department of Mathematics
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Dear David,

As the Chair of the Departments of Molecular Genetics and Plant Cellular and Molecular Biology I wish to express the support of my department for the Master Degree program in Mathematical Biology that your department has developed. We strongly support this new degree program as evidenced by our design and implementation of a two-quarter series of courses in biology adapted to mathematics graduate students (MG660/MG661). Drs. Erich Grotewold and Helen Chamberlin, faculty members of the Plant Cellular and Molecular and Molecular Genetics, respectively, merging departments have designed the courses and have taught them this year for the first time. The courses provide the students with an excellent understanding in molecular, cell, and systems biology, so that they can freely communicate with biologists, as they bring mathematics to bear on the biology. It is clear that in the age of genome sequencing, microarray genome-wide analyses, and modeling of complex biological processes that it is essential for young scientists to be cross-trained in the biological and mathematical sciences and that is exactly what the Master's degree program will accomplish.

Members of MG/PCMB are also interested to have master students conduct summer internships with them, in the same way that MBI postdoctoral scholars have worked with our faculty on joint research projects. We shall help coordinate the matching between the students and the biology faculty.

Best Regards

Anita Hopper, Chair
Department of Molecular Genetics
Interim Chair, Plant Cellular and Molecular Biology



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October 20, 2009

Professor Avner Friedman
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Columbus, Ohio 43210

Dear Dr. Friedman:

As Dean of The Ohio State University College of Education and Human Ecology, I am writing to express my enthusiastic support for the new initiative of the OSU Mathematics Department that seeks to create professional Masters degree programs of high quality and high relevance to scientific and technological workforce needs. I have been happy to have facilitated the work of our College's Mathematics Education Group in the creation and implementation of one of the four contemplated professional Masters degrees, namely the Masters Degree in Mathematics for Mathematics Educators.

The math and science education workforce is the resource that underlies all scientific and technological workforce programs. They provide the floor on which all math-based professionals stand. Not every high quality research university Mathematics Department understands the role it must play if our teacher-leaders, administrators, and education researchers are to be truly excellent and plentiful enough to meet the nation's challenges. Rigorous and appropriate mathematical formation is key to the advancement of the entire enterprise. That is precisely what I see being provided by this new program.

Mathematics education Ph.D. with strong mathematics Masters degrees are in short supply in the education world--posts at colleges and universities go begging year-after-year because schools want education professionals that can handle (and teach) them mathematics as well. Private industry also looks for those with a strong quantitative formation, but preferably with the communication skills to match. Again I see this new degree program as perfectly suited to the need.

Our college will cooperate fully in making this new program happen, making it of high quality, and, we trust, in making it into a state and national model.

Sincerely,

A handwritten signature in black ink that reads "Cheryl Achterberg".

Cheryl Achterberg
Dean

CA/lg

From: "Wilson-Hill, Rose" <Wilson-Hill.46@osu.edu>
Date: November 9, 2009 11:44:51 AM EST
To: "Herb Clemens" <clemens@math.ohio-state.edu>
Cc: "Stewart, Mac" <Stewart.6@osu.edu>, "Lipscomb, Jackie" <lipscomb.3@osu.edu>
Subject: RE: New tracks in the MMS in Mathematics

Dr. Herb Clemens
Professor
Department of Mathematics
The Ohio State University

Dear Professor Clemens,

The Office of Minority Affairs is pleased to send you this communiqué in support of seeking qualified candidates for the new Mathematics Master's degree specializations (mathematical biology, mathematics education, mathematics of finance and computational science).

It will be our privilege to collaborate with you through the Annual Graduate & Professional Schools Visitation Days. To begin, we will be very specific about your needs in our early marketing to the more than 60 colleges and universities. We will work together to establish contacts at a number of the universities prior to GPSVD, so that you can have a pool of candidates visiting with direct interest in the new Math Master's specializations. As you know, students who are seniors must have a 3.4 or above cumulative grade point average and complete the on-line graduate application as a prerequisite to GPSVD. We might even suggest establishing a selected 'OSU Math Faculty-to-Visiting Faculty Collaborative', to capture the attention of sophomores and juniors with whom you can have ongoing exchange for at least two years prior to the GPSVD visit, generating an important pipeline.

And, thank you again for being a part of the 39th Annual Graduate & Professional Schools Visitation Days (GPSVD). We shall look forward to the 40th on November 7 – 9, 2010.

Most cordially,

Rose A. W-H.

Rose A. Wilson-Hill
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