Fiscal Unit/Academic Org	Mathematics - D0671
Administering College/Academic Group	Arts and Sciences
Co-adminstering College/Academic Group	
Semester Conversion Designation	New Program/Plan
Proposed Program/Plan Name	Mathematics Graduate Minor
Type of Program/Plan	Graduate minor
Program/Plan Code Abbreviation	MATH-GM
Proposed Degree Title	Graduate Minor in Mathematics

Credit Hour Explanation

Program credit hour requirements		A) Number of credit hours in current program (Quarter credit hours)	B) Calculated result for 2/3rds of current (Semester credit hours)	C) Number of credit hours required for proposed program (Semester credit hours)	D) Change in credit hours
Total minimum credit hours required for completion of program				15	
Required credit hours offered by the unit	Minimum			15	
	Maximum			15	
Required credit hours offered outside of the unit	Minimum				
	Maximum				
Required prerequisite credit hours not included above	Minimum				
	Maximum				

Program Learning Goals

Note: these are required for all undergraduate degree programs and majors now, and will be required for all graduate and professional degree programs in 2012. Nonetheless, all programs are encouraged to complete these now.

Program Learning Goals

- Students of the Graduate Minor acquire conceptual knowledge and problem solving skills in a wide range of mathematical subjects at a high level of abstraction, sophistication, and rigor.

Assessment

Assessment plan includes student learning goals, how those goals are evaluated, and how the information collected is used to improve student learning. An assessment plan is required for undergraduate majors and degrees. Graduate and professional degree programs are encouraged to complete this now, but will not be required to do so until 2012.

Is this a degree program (undergraduate, graduate, or professional) or major proposal? No

Program Specializations/Sub-Plans

If you do not specify a program specialization/sub-plan it will be assumed you are submitting this program for all program specializations/sub-plans.

Pre-Major

Does this Program have a Pre-Major? No

Attachments

- Grad_Minor_Cover_Letter_2017_12_09.pdf: Cover Letter

  (Letter from Program-offering Unit. Owner: Kerler,Thomas)
- Math_Grad_Minor_Proposal_2017_12_09_FINAL.pdf: Grad Minor Proposal

  (Program Proposal. Owner: Kerler,Thomas)
- Math_Grad_Minor_AdvisingSheet_2017_12_09_FINAL.pdf: GM Advising Sheet

  (Semester Advising Sheet(s). Owner: Kerler,Thomas)
- Math_Grad_Minor_Proposal_REVISED_2018_02_02.pdf: Revised Grad Minor Proposal

  (Program Proposal. Owner: Kerler,Thomas)
- Math_Grad_Minor_AdvisingSheetDraft_REVISED_2018_02_02.pdf: Revised GM Advsing Sheet

  (Semester Advising Sheet(s). Owner: Kerler,Thomas)

Comments

- Revised Proposal and Advising Sheet were uploaded.

  Revisions include:

  - Minimum grades changed to 'B'

    (redundant GPA requirement removed)

  - Further explanation about the limitation to 5000,6000 level for

    the 9-hour requirement added.

  - Further explanation for accelerated curricula for students with

    candidacy time-limits added.

  - Phase-In section added

  - Miscellaneous edits and corrections of clerical errors. *(by Kerler,Thomas on 02/02/2018 10:02 AM)*
- Returned at the request of the program. *(by Toft,Jill A on 01/24/2018 03:06 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Kerler,Thomas	12/09/2017 05:46 PM	Submitted for Approval
Approved	Husen,William J	12/10/2017 08:17 AM	Unit Approval
Approved	Haddad,Deborah Moore	12/10/2017 12:21 PM	College Approval
Revision Requested	Toft,Jill A	01/24/2018 03:06 PM	GradSchool Approval
Submitted	Kerler,Thomas	02/02/2018 10:03 AM	Submitted for Approval
Approved	Husen,William J	02/02/2018 10:03 AM	Unit Approval
Approved	Haddad,Deborah Moore	02/02/2018 12:14 PM	College Approval
Revision Requested	Toft,Jill A	02/06/2018 11:05 AM	GradSchool Approval
Submitted	Husen,William J	02/06/2018 11:12 AM	Submitted for Approval
Approved	Husen,William J	02/06/2018 11:12 AM	Unit Approval
Pending Approval	Vankeerbergen,Bernadette Chantal	02/06/2018 12:32 PM	Ad-Hoc Approval
Approved	Haddad,Deborah Moore	02/06/2018 12:33 PM	College Approval

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

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December 9th, 2017

Graduate Council
250 University Hall

RE: Proposal for a Graduate Minor in Mathematics.

Dear Colleagues,

On behalf of the Graduate Studies Committee (MGSC) of the Department of Mathematics I am pleased to submit a proposal for a new Graduate Minor in Mathematics via upload to the curriculum.osu.edu system. The proposal was approved by the MGSC on March 3rd of this year and is support by our graduate faculty.

The uploaded proposal includes a rationale for the minor, a description of the proposed curriculum, an outline of the administrative arrangements to support the new minor, and enrollment plans and estimates. In addition, we have attached an advising sheet to be used by students and advisors of the minor.

Thank you very much for your consideration of our proposal.

Sincerely,

Thomas Kerler

Thomas Kerler
Professor & Vice-chair
Department of Mathematics

PROPOSAL FOR A GRADUATE MINOR IN MATHEMATICS

The Graduate Studies Committee (MGSC) of the Department of Mathematics is proposing a new Graduate Minor in Mathematics (GM). The proposal was approved by the MGSC on March 3rd, 2017.

Rationale

Graduate level mathematics courses have seen a steady increase in enrollment by graduate students from other programs at the Ohio State University (OSU) over the past years.

Notably, students from Computer Science and also other engineering departments frequently visit our master and doctoral level courses in topology and geometry, as problems in spatial modeling or topological data analysis require more and more sophisticated mathematical background. Students from Statistics routinely benefit from our advanced courses in probability theory and combinatorics. The Mathematics department also has a large faculty group in mathematical biology, and co-hosts the Mathematical Biosciences Institute. As a result, the department provides and teaches courses of great interest to students in life science departments who want to acquire the skills needed for mathematical modeling. Further examples include students from Philosophy attending logic and foundational courses, as well as students studying theoretical physics attending a broad range of graduate mathematics courses.

In recent times, one or two students each year manage to earn an MS degree in our program. However, by our estimate, many more students complete substantial graduate coursework in mathematics, without having this recognized in an official manner on their transcripts. There is also no good mechanism currently in place that would allow the mathematics department to advise these students on what mathematics courses would be appropriate and helpful to them.

With the proposed GM we aim to allow doctoral students from other programs, who have taken graduate level mathematics classes, but do not chose to obtain an MS degree, to have their advanced training in mathematics officially certified. The GM would create a framework to better guide such students through our course offerings, and, more generally, provide incentives for talented students to acquire knowledge in graduate level mathematics -- knowledge that is becoming increasingly relevant in many other areas of science.

Eligibility

The proposed minor is open only to *doctoral* students in any graduate program at OSU. Other degree students (JD, MD, MS, MA, etc.) may be considered in special circumstance with the approval of the MGSC.

Students seeking to earn the GM further need to adhere to the enrollment, approval, and supervision process described in the sections on administration and enrollment below. Students also need to be in good academic standing with the university and their home programs.

Proposed Curriculum and Requirements

In order to obtain a GM, a student is required to complete a minimum of **15 credit hours** of approved graduate level mathematics courses. A complete set of these courses is listed in the appendix. An approved curriculum must further fulfill the following requirements:

- At least **4** mathematics courses at the 5000-level or higher must be counted towards the GM requirements.
- All courses counted towards the GM must be passed with a grade of B or better, or an S for S/U graded courses, in compliance with Graduate School rules (Handbook, § 8.4).
- At most **3** credit hours of S/U graded courses may be counted towards the GM.

- At least **9** credit hours of the coursework counted towards the GM must be from letter graded mathematics courses at the 5000 or 6000 level.
- Group study courses (5194, 6194), internship courses (6191) and graduate research courses (6998, 6999, 7998, 8998, 8999) are not allowed to count towards the GM.
- The study plan needs to be approved by the department.

S/U graded courses include independent studies courses, research and internship courses, as well as 7000-level courses with the .02-decimalization.

The requirements above allow nearly all graduate mathematics courses to count towards the GM, in order to respond to the wide range of mathematical topics found in quantitative disciplines, and the observed outside participation across our entire course offerings.

This is balanced with the stipulation that at least 60% of the coursework is from seriously graded courses with substantial skill training based on homework and exams, as well as the approval of study plans as described below. Courses beyond the 6000 level can be counted towards the 9 hours from the fourth item above only with special permission by the GSC. A respective petition to the GSC will require evidence that a 7000 or 8000 level course applies sufficiently rigorous skill-assessments and grading standards (in a manner comparable to a 5000 or 6000 level course), and that the student has adequate preparations to takes the course.

Administration & Approval of Study Plans

The administration of the GM will be chiefly the responsibility of the MGSC with logistic and clerical assistance by the Graduate Coordinator (GC) and further oversight by the Vice-chair for Graduate Studies (VCG).

To this end the MGSC will appoint each year a *Graduate Minor Chair* (GMC) from the Mathematics graduate faculty.

The principal responsibility of the GMC is the approval, on behalf of the MGSC, of study plans in accordance with the stated rules. Every student enrolling in the GM needs to confer with the GMC in order to discuss a plan of study in accordance with the general rules stated above. The GMC needs to approve the plan of study as well as coordinate later adjustments with the MGSC and the Graduate School.

The sample study plans listed below provide a guide for the GMC, and illustrate some types of plans that would be acceptable and beneficial for a broad range of students with reasonable mathematical background. More advanced options may require more careful evaluation of preparations, and more substantial deviations might require the GMC to consult with the MGSC.

The GMC may also coordinate such approvals with other graduate faculty in the department with better knowledge of a particular specialization. Also, the GMC may contact the GSC chair of the student's home department if there are doubts about the student's academic standing in the home program.

The course requirements will be recorded in the attached Advising Sheet which will be signed by the GMC upon completion, and collected by the GC. The VCG will be informed by the GC and GMC of the completion, and will approve the transcript designation form submission by the student on gradforms.osu.edu following the Graduate School process. The GMC will prepare annual reports of earned GM's and submit them to the MGSC.

Enrollment

Before enrollment students need to have their study plan approved by the GMC. Previously taken courses may count towards the GM requirements. Students are asked to present the most recent Advising Report to the GMC for the proper evaluation of their background, the adequacy of the study plan, and their academic standing. The GMC will inform the MGSC chair, the VCG, and the GC of the approval.

The student follows the Graduate Schools online application procedures (via gradforms.osu.edu) and the VCG will approve the application subject to GMC approval and possible further departmental criteria. The online process involves approval by the Graduate School and electronic communication with the student and the student's advisor.

The department expects to enroll about 5-10 students in the GM during the initial phases of the program. The total number of students enrolled will be limited to 15, mainly in order to be able to guarantee an orderly and sustainable process, both administratively and in terms of academic oversight. If there is a demand beyond this number, the department will reevaluate the administrative procedures and requirements for the GM.

The GC and VCG will also monitor long-time enrollment in the GM. If a student has not completed their GM requirements within 3 years of the initial application, the progress of the students will be reevaluated, which might result in disenrollment.

Phase-In

The GM will be open to students who have started enrollment into their respective doctoral program no earlier than 13 months before the approval and inception of this degree program. (So, if, for example, the minor is approved by Autumn 2018, students should not have been enrolled before Autumn 2017). Retroactive course credits and exceptions are at the discretion of the MGSC.

Sample Curricula

The following sample curricula were proposed by mathematics faculty after consultation with colleagues from other departments, and were considered as adequate by the MGSC. They may, thus, be considered as pre-approved assuming adequate preparation by the student. The curricula are organized by specialization of the student, and the separation into first and second year is meant only as a suggestion. Students whose programs require candidacy by the end of their second year are encouraged to either complete accelerated versions of these curricula in their first two years or, after candidacy, substitute 8999 hours in their program by GM electives with permission of their departments.

1. Engineering & Physics

Background in advanced calculus and differential equations at the 4000-level.

First year: Math 5101, 5102

Second year: Math 5756, 5757

Third year: Math 5451

2. Economics & Finance

Required background in calculus and probability theory.

First year: Math 5632

Second year: Math 5633, 5634

Third year: Math 5635, 5637

3. Philosophy & Foundations

Background in advanced calculus and linear algebra.

First year: Math 5111, 5001

Second year: Math 5201, 5051

Third year: any Math 6001-6004 course

4. Life Science Departments

Background in calculus and life sciences.

First year: Math 5401, 5402

Second year: Math 5660, 5602

Third year: 5651 or 6601

(or any five of the six listed courses)

5. Statistics

Curricula have further sub-specializations depending on the student's interest. Doctoral students in statistics should have all prerequisite preparations. Foundational courses for *all* sub-specializations:

(First and second year): Math 5201, 5202 and Math 5101

One or two additional courses depending on sub-specialization (third year):

- *Discrete data analysis and optimization*:
  Math 6501, Math 5601, or Math 5603
- *Shape analysis*:
  Math 5702, Math 6701, or Math 6702
- *Nonparametric function estimation*:
  Math 5102, Math 5601, Math 5603
- *Probability*:
  Math 6501, Math 6502, or Math 8250

6. Computer Science

Students are expected to have solid background in calculus and linear algebra. There are three proposed curricula depending on the student's sub-specialization and interests.

- *Computational Geometry and Topology*:
  First year: Math 5702, 5801
  Second year: Math 6501, 6502
  Third year: Math 8710 or 8800
- *Distributed computing/temporal logic*:
  First year: Math 5051 and any one of Math 6001-6004
  Second year: Any one of Math 6001-6004
  Third year: Math 6251, 6252
- *Nonparametric function estimation*:

First year: Math 5201, 5202
Second year: Math 6251, 6252
Third year: One of Math 6501, 6502, or 7211

Attachments

- Cover Letter by VCG
- Advising Sheet

Appendix: Mathematics Graduate Level Courses

Course #	Course Title	Credits
5001	Introduction to Set Theory	3.0
5051	Introduction to Mathematical Logic	3.0
5101	Linear Mathematics in Finite Dimensions	3.0
5102	Linear Mathematics in Infinite Dimensions	3.0
5111	Algebra I	5.0
5112	Algebra II	5.0
5152	Introduction to Number Theory with Applications	3.0
5168	Introduction to the Finite Element Method	3.0
5201	Introduction to Real Analysis I	5.0
5202	Introduction to Real Analysis II	5.0
5221	Introduction to Complex Analysis	3.0
5251	Complex Variables and Applications	3.0
5401	Applied Differential Equations I	3.0
5402	Applied Differential Equations II	3.0
5421	Mathematics of Infectious Disease Dynamics	3.0
5451	Calculus of Variations and Tensor Calculus	3.0
5520H	Honors Linear Algebra and Differential Equations	5.0
5522H	Honors Complex Analysis	5.0
5529H	Honors Combinatorics	5.0
5530H	Honors Probability	5.0
5540H	Honors Differential Geometry	5.0
5576H	Honors Number Theory	5.0
5590H	Honors Abstract Algebra I	5.0
5591H	Honors Abstract Algebra II	5.0
5601	Essentials of Numerical Methods	3.0
5602	Computational Partial Differential Equations	3.0
5603	Numerical Linear Algebra	3.0
5630	Life Contingencies I	3.0
5631	Life Contingencies II	3.0

Course #	Course Title	Credits
5632	Financial Economics for Actuaries	3.0
5633	Loss Models I	3.0
5634	Loss Models II	3.0
5651	Mathematical Modeling of Biological Processes	3.0
5660	Integrated Molecular and Cellular Biology for Non-Biologists	5.0
5702	Curves and Surfaces in Euclidean Three Space	3.0
5756	Mathematical Methods in Relativity Theory I	3.0
5757	Mathematical Methods in Relativity Theory II	3.0
5801	General Topology and Knot Theory	3.0
6001	Advanced Mathematical Logic I: Proof Theory	3.0
6002	Advanced Mathematical Logic II: Model Theory	3.0
6003	Advanced Mathematical Logic III: Set Theory	3.0
6004	Advanced Mathematical Logic IV: Computability Theory	3.0
6111	Abstract Algebra I	5.0
6112	Abstract Algebra II	5.0
6151	Commutative Algebra	3.0
6152	Non-Commutative Algebra	3.0
6193	Individual Studies in Mathematics	
6211	Real Analysis I	5.0
6212	Real Analysis II	5.0
6221	Complex Analysis I	3.0
6222	Complex Analysis II	3.0
6251	Theory of Probability I	4.0
6252	Theory of Probability II	4.0
6411	Ordinary Differential Equations I	3.0
6451	Partial Differential Equations I	3.0
6501	Combinatorics and Graph Theory I	3.0
6502	Combinatorics and Graph Theory II	3.0
6601	Numerical Methods in Scientific Computing I	4.0
6602	Numerical Methods in Scientific Computing II	4.0
6701	Differentiable Manifolds	3.0
6702	Differential Geometry	3.0
6801	Algebraic Topology I	3.0
6802	Algebraic Topology II	3.0
7121.01	Algebraic Number Theory	3.0
7121.02	Algebraic Number Theory	3.0
7122.01	Analytic Number Theory	3.0
7122.02	Analytic Number Theory	3.0
7141	Algebraic Geometry I	3.0
7142	Algebraic Geometry 2	3.0
7161.01	Lie Algebras	3.0

Course #	Course Title	Credits
7161.02	Lie Algebras	3.0
7162.01	Lie Groups and Representation Theory	3.0
7162.02	Lie Groups and Representation Theory	3.0
7193	Individual Studies in Mathematics	
7211	Functional Analysis I	3.0
7212	Functional Analysis II	3.0
7221.01	Ergodic Theory I	3.0
7221.02	Ergodic Theory I	3.0
7222.01	Ergodic Theory II	3.0
7222.02	Ergodic Theory II	3.0
7412.01	Ordinary Differential Equations II	3.0
7412.02	Ordinary Differential Equations II	3.0
7413	Ordinary Differential Equations III	3.0
7452	Partial Differential Equations II	3.0
7453	Partial Differential Equations III	3.0
7611	Computational Partial Differential Equations I	3.0
7612	Computational Partial Differential Equations II	3.0
7651	Applied Complex Variables and Asymptotics I	3.0
7652	Applied Complex Variables and Asymptotics II	3.0
7711	Riemannian Geometry	3.0
7721	Kahler Geometry	3.0
7811.01	Homotopy Theory	3.0
7811.02	Homotopy Theory	3.0
7851	Differential Topology I	3.0
7852	Differential Topology II	3.0
8000	Topics in Foundations of Mathematics	3.0
8110	Topics in Algebra	3.0
8120	Topics in Number Theory	3.0
8140	Topics in Algebraic Geometry	3.0
8160	Topics in Representation Theory	3.0
8210	Topics in Real Analysis	3.0
8220	Topics in Complex Analysis	3.0
8250	Topics in Probability Theory	3.0
8300	Topics in Financial Mathematics	3.0
8410	Topics in Ordinary Differential Equations	3.0
8420	Topics in Partial Differential Equations	3.0
8500	Topics in Combinatorics	3.0
8610	Topics in Applied Mathematics	3.0
8650	Topics in Mathematical Biology	3.0
8710	Topics in Differential Geometry	3.0
8750	Topics in Lie Theory	3.0
8800	Topics in Topology	3.0

Graduate Minor in Mathematics
Advising Sheet

Prerequisites:

- Doctoral student in an Ohio State graduate program.
- In good academic standing with the university and the home program.

Requirements:

- Complete **15 credit hours** of **approved** graduate level mathematics courses (consult webpage).
- At least **4** mathematics courses at the 5000-level or higher must be counted towards the GM requirements.
- All courses counted towards the GM must be passed with a grade of B or better or an S for S/U graded courses.
- At most **3** credit hours of approved S/U graded courses may be counted towards the GM.
- At least **9** credit hours of the coursework counted towards the GM must be from letter graded mathematics courses at the 5000 or 6000 level.

Study Plan:

The study plan needs to be completed by the student with approval of the Graduate Minor Chair (GMC) before enrolling. An Advising Report should be presented to the GMC. Further the form needs to be completed with grades and adjustments and signed by the GMC for the final approval of the minor transcript designation.

	Course #	Abbr Title	Semester/Year	Credit Hrs	Grade
1					
2					
3					
4					
5					
6					
			Last	**Total**	**GPA**

Approval:

Graduate Minor Form - GMC Approval (Study Plan & Enrollment):

____Date:

Graduate Minor Transcript Designation - GMC Approval (Grades & Requirements):

____ Date:

Suggested Curricula

1. Engineering & Physics
First year: Math 5101, 5102

Second year: Math 5756, 5757

Third year: Math 5451

2. Economics & Finance
First year: Math 5632,

Second year: Math 5633, 5634

Third year: Math 5635, 5637

3. Philosophy & Foundations
First year: Math 5111, 5001

Second year: Math 5201, 5051

Third year: any Math 6001-6004 course

4. Life Science Departments
First year: Math 5401, 5402

Second year: Math 5660, 5602

Third year: 5651 or 6601

(or any five of the six listed courses)

5. Statistics
- *Discrete data analysis and optimization*:
  Math 6501, Math 5601, or Math 5603
- *Shape analysis*:
  Math 5702, Math 6701, or Math 6702
- *Nonparametric function estimation*:
  Math 5102, Math 5601, Math 5603
- *Probability*:
  Math 6501, Math 6502, or Math 8250

6. Computer Science
- *Computational Geometry and Topology*:
  First year: Math 5702, 5801
  Second year: Math 6501, 6502
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- *Distributed computing/temporal logic*:
  First year: Math 5051 and any of Math 6001-6004
  Second year: Math 6251, 6252
- *Nonparametric function estimation*:
  First year: Math 5201, 5202
  Second year: Math 6251, 6252
  Third year: One of Math 6501, 6502, or 7211