

- The formation/composition of the Advising Committee and/or Thesis Committee for the student.
 - The approval procedure for students choosing an advisor and for the topic of his/her thesis. What is the role of the industry mentor?
 - Discussion of how the progress of student will be monitored.
-
- Please describe the non-thesis option in greater detail. How does a practicum and/or capstone experience contribute to this option? What is considered a pass on the final exam?
 - Will an advising sheet be used to help students track their progress in the program?
 - The first sentence under the “Faculty and Staff Recourses (sic), Facilities” is confusing. I believe you mean to say that, at first, there will be no need to hire additional faculty since part-time lectures will be hired.
 - Is the enrollment in this new degree expected to influence enrollment in the other Master’s programs within the Department of Mathematics?
 - Please add credit hours to the final Sample Schedules table.
 - Though not yet required, you may consider filling out the Ohio Board of Regents Financial Impact Statement at this time.

Please resubmit the revised proposal to me at your convenience. Unlike the PDP which will later be submitted to the Regents, there is no page limitation at this stage of the approval process. After we receive it, I will schedule it for review at an upcoming Graduate School Curriculum meeting. Subsequently, the proposal will be submitted to the Graduate Council, to the Committee on Academic Affairs, to the University Senate, and finally to the Board of Trustees. After the proposal has obtained approval from the University Senate, we will begin the submission process to the Ohio Board of Regents. Throughout all, I will be working with you, helping to shepherd this proposal through its entire path among these committees.

Please don't hesitate to contact me with questions or clarifications.

Many thanks,



Scott Herness
Associate Dean
The Graduate School



Graduate School

250 University Hall
230 North Oval Mall
Columbus, OH 43210-1366

June 4, 2013

Phone (614) 292-6031
Fax (614) 292-3656

Dr. Thomas Kerler, PhD
Vice Chair for Graduate Studies
Department of Mathematics

Master of Quantitative Risk Management

Thomas,

The graduate school curriculum committee (GSCC) met on May 27th and, among its agenda items, considered the proposal to create a new tagged Master's degree, Master of Quantitative Risk Management in the Department of Mathematics.

The degree would train students in applications of financial mathematics and actuarial science to the management of financial and insurance risk. The GSCC appreciated the need for this degree; it fits well into the goals of professional masters degrees which the Graduate School encourages. The degree would entail both thesis or non-thesis options with totals of 36 and 39 credit hours, respectively. For the most part, the curriculum is presented in a straightforward manner.

The goal of review within the Graduate School is not only to gain Graduate School approval of this new degree but also to strengthen the proposal for the subsequent approval steps it will require as it moves towards the Ohio State University Board of Trustees and the Ohio Board of Regents. Here I'd like to summarize changes and clarifications to the proposal as a result of our discussion.

- Letters of concurrence will be necessary for the courses in the curriculum which are taught outside of your unit. This would include courses from the Dept. of Statistics, the Dept. of Computer Sciences, and the Dept. of Finance.
- The proposal calls for the creation of four new courses. More information, such as syllabi, would be helpful on these courses.
- Absent from the proposal were essential aspects of program administration and student advising. Among the items that should be discussed:
 - The formation/composition of the graduate studies committee and its chair and how this committee will interface with the MQRM committee. Please note that not everyone on the MQRM committee would be eligible to serve on the graduate studies committee.

- The formation/composition of the Advising Committee and/or Thesis Committee for the student.
- The approval procedure for students choosing an advisor and for the topic of his/her thesis. What is the role of the industry mentor?
- Discussion of how the progress of student will be monitored.

- Please describe the non-thesis option in greater detail. How does a practicum and/or capstone experience contribute to this option? What is considered a pass on the final exam?

- Will an advising sheet be used to help students track their progress in the program?

- The first sentence under the “Faculty and Staff Recourses (sic), Facilities” is confusing. I believe you mean to say that, at first, there will be no need to hire additional faculty since part-time lectures will be hired.

- Is the enrollment in this new degree expected to influence enrollment in the other Master’s programs within the Department of Mathematics?

- Please add credit hours to the final Sample Schedules table.

- Though not yet required, you may consider filling out the Ohio Board of Regents Financial Impact Statement at this time.

Please resubmit the revised proposal to me at your convenience. Unlike the PDP which will later be submitted to the Regents, there is no page limitation at this stage of the approval process. After we receive it, I will schedule it for review at an upcoming Graduate School Curriculum meeting. Subsequently, the proposal will be submitted to the Graduate Council, to the Committee on Academic Affairs, to the University Senate, and finally to the Board of Trustees. After the proposal has obtained approval from the University Senate, we will begin the submission process to the Ohio Board of Regents. Throughout all, I will be working with you, helping to shepherd this proposal through its entire path among these committees.

Please don't hesitate to contact me with questions or clarifications.

Many thanks,



Scott Herness
Associate Dean
The Graduate School



Graduate School

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Phone (614) 292-6031
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November 21, 2013

Dr. Thomas Kerler, PhD
Vice Chair for Graduate Studies
Department of Mathematics

Master of Quantitative Risk Management

Thomas,

Thank you for re-submitting the proposal to create a new tagged Master's degree, Master of Quantitative Risk Management in the Department of Mathematics. The Graduate School Curriculum Committee (GSCC) met on November 12th and reviewed the revised proposal. Originally, the committee had considered the proposal at its May 27th meeting and my letter of June 4th summarized clarifications and revisions requested by the committee from that meeting.

The GSCC viewed the revision as strongly improved. They do, however, have a few remaining questions. Their previous major concerns—letters of concurrence, syllabi for the four newly created courses, and clarifying essential aspects of program administration and student advising—were all satisfactorily addressed in the revised proposal. However, a few issues remain outstanding:

- The GSCC would like to see a formal advising sheet to be used by students in the program. This advising sheet will be needed for subsequent review by the Council on Academic Affairs as well.
- The GSCC would still like some additional narrative describing the non-thesis option in greater detail. More detail about the nature of the comprehensive exams, how they will be administered and graded would be appreciated.

Please resubmit the revised proposal to me at your convenience. Once the GSCC has approved these final changes I will submit the proposal to the Graduate Council and subsequently to the Committee on Academic Affairs. Following approval by the

University Senate, we will begin the submission process to the Ohio Board of Regents. Please don't hesitate to contact me with questions or clarifications.

Many thanks,



Scott Herness
Associate Dean
The Graduate School

THE OHIO STATE UNIVERSITY
**GRADUATE
SCHOOL**
Advancing graduate education for over 100 years



Graduate School

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March 10, 2014

Dr. Thomas Kerler, PhD
Vice Chair for Graduate Studies
Department of Mathematics

Master of Actuarial and Quantitative Risk Management

Thomas,

Thank you for re-submitting the proposal to create a new tagged Master's degree, Master of Quantitative Risk Management in the Department of Mathematics. The Graduate School Curriculum Committee (GSCC) met on February 25th and reviewed the revised proposal. However, the GSCC noted that a few points which they had requested were not addressed.

The GSCC viewed the revision as strongly improved. Their previous major concerns—syllabi for the four newly created courses and clarifying essential aspects of program administration and student advising—were all satisfactorily addressed in the revised proposal. However, a few issues remain outstanding:

- The GSCC had requested letters of concurrence for the courses in the curriculum which are taught outside of your unit. This would include courses from the Dept. of Statistics, Computer Sciences, and Finance. We did not see these letters. Concurrence letters are a common feature of proposal development and will be needed for CAA review.
- Details of the non-thesis option are provided. However the formation of the Master's examination committee and the grading of the non-thesis exam are not clear. In the proposal, two individuals (Evans, Heyer) are listed as helping to design/write their respective portions of the non-thesis exam. Neither is eligible to hold graduate faculty status and hence neither would be eligible to serve as a regular member of the committee nor grade exams. They could serve as additional members of the committee on a petition basis. It should be made clear that graduate faculty will be responsible for administering and grading the non-thesis exam. The basis of a passing grade on the non-thesis exam should also be included.

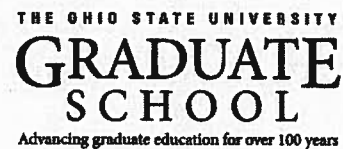
- The committee appreciates the student advising sheet which was submitted. For your consideration, typically student advising sheets are more tabular and interactive, providing students with places to notate where and how they've completed program requirements.

Please resubmit the revised proposal to me, using curriculum.osu.edu, at your convenience. I will subsequently submit the proposal to the Graduate Council. Following these approval steps in the Graduate School, the proposal will be routed to the Committee on Academic Affairs. We will then being final steps towards OSU Board of Trustees and Ohio Board of Regents approval. Please don't hesitate to contact me with questions or clarifications.

Many thanks,



Scott Herness
Associate Dean
The Graduate School





April 8th, 2014

Dean Scott Herness
Graduate School
The Ohio State University
250E University Hall

RE: Proposal for the planned Master in Actuarial and Quantitative Risk Management (MAQRM).

Dear Scott,

We have uploaded the our fourth submission to the Graduate School of the MAQRM proposal to curriculum.osu.edu web site. I am summarizing below revisions that occurred since the original submission though ASC about a year ago.

1. Revisions that are included in the **November 4, 2013** proposal. This was submitted to you directly per your request from 6/5/2013 in your letter responding to the original ASC submission.
 - All courses from Finance and Computer Science were removed from the list of required and elective courses (see Appendix 3). All remaining courses are either in mathematics or statistics.
 - A letter of concurrence from Statistics was supplied. (by Craigmile from 9/10/2013).
 - Complying with the statistics letter the parenthetical remark concerning Stat 6301/6302 has been removed, and the suggested course 6605 has been included in the list of electives. As Stat 6550 is only one of several electives so that the offering pattern is not a concern. Financial concerns will not be an issue with initial enrollment numbers and are covered by the support of the ASC and NMS deans expressed in their letters (see further remark in last version).
 - A letter of from the Fisher College of Business is supplied. (by Wruck and Werner from 10/2/2013). The letter concurs with the offering of the degree under the new name and assures that there is no conflict with one of their planned degrees. The letter does not address courses since there are no finance courses in this proposal. (The business will not give concurrence for courses).
 - Since there are no Computer Science courses in the curriculum and there is no conflict with any Computer Science degrees no concurrence letters are needed.



- Course descriptions for Math 5588, 5633, 5634, 6630, 6631, 6632 have been supplied.
 - The formation and function of the MAQRMP is described in Section 4. The added paragraph also addresses issues concerning the interaction with the GSC, its role in annual student evaluations, and assigning advisors.
 - The role of industry mentors is described in more detail at the end of Section 4.
 - An explanation is given how our GSC is formed.
 - Additional explanations about the non-thesis option are offered in Section 3.
 - A statement is added at the end of Section 6 that the MAQRMP has no bearing on our other degree programs.
 - A note on advanced students at the end of the Appendix below the schedules was removed.
 - Miscellaneous minor corrections, including rewriting the beginning sentence of Section 7 and adding credit hours to the sample schedules.
2. Revisions that are included in our **December 25, 2013** proposal. This was submitted to you directly per your request from 11/21/2013 in your letter responding to our submission above from 11/4.
- An advising sheet was submitted. We also answer a question from the previous letter that we do not normally use advising sheets at the graduate level and not plan to do so for this degree. However, we have been and will continue to use GradCentral for tracking student progress.
 - A detailed description of the non-thesis option examination is added in Section 3. Particularly, the format of the exam and the five main areas that candidates can choose from are specified. The source of the content on which passing is based and the passing decision through the committee outlined also in this section.
3. Revisions that are included in our **current proposal**. This has been submitted today via curriculum.osu.edu per your request from 11/21/2013 in your letter responding to our submission above from 12/25.
- The concurrence issues were already settled in our proposal from 11/4/2013.
 - Further detail on the non-thesis option examination is provided, particularly assurances that we will follow university rules. Additional graduate faculty are named that serve on examination committees, and it is clarified that non-graduate faculty will serve only as added members via petition. (see Section 3)
 - Additional comments are provided addressing passing criteria for the examination. (Section 3)
 - External contributors to the topics and project courses are identified as invited lecturers and distinguished from instructors of record, that will be graduate faculty who will be responsible for assigning grades. (Section 7)
 - Additional lines, boxes, and other layout elements for students annotations are added to the updated Advising Sheet.



- A clarification is added in Appendix 4 that Math 3618 does not count towards requirements.
- Further miscellaneous minor editorial updates.

Let me know if you have any more questions.

Sincerely,

Vice-chair for Graduate Studies
Associate Professor of Mathematics



College of Arts and Sciences

186 University Hall
230 North Oval Mall
Columbus, OH 43210

Phone (614) 292-1667
Fax (614) 292-8666
<http://artsandsciences.osu.edu>

April 12, 2013

Dr. Joseph A. Alutto
Executive Vice President and Provost
Office of Academic Affairs
203 Bricker Hall
190 North Oval Mall
CAMPUS

Dear Joe:

As proposed by the Department of Mathematics and approved through our college curriculum process, the Masters program in Quantitative Risk Management has the full support of the College of Arts and Sciences.

This new graduate program will enhance the existing offerings of the university and certainly will resonate well with the current needs of insurance and finance entities in Ohio and throughout the nation and the world. This new degree program provides new opportunities to educate students in quantitative risk management, and we appreciate your consideration for the next stage of approval of this new program.

Sincerely,

A handwritten signature in blue ink that reads "Joseph E. Steinmetz".

Joseph E. Steinmetz, PhD
Executive Dean and Vice Provost



College of Arts and Sciences

186 University Hall
230 N. Oval Mall
Columbus, OH 43210

Phone (614) 292-8908
Fax (614) 292-8666

February 15, 2013

Joseph A. Alutto
Executive Vice President and Provost
Office of Academic Affairs
203 Bricker Hall
190 North Oval Mall
Campus

Dear Joe:

The Master of Quantitative Risk Management (MQRM) proposed by the Mathematics Department has the support of the Division of Natural and Mathematical Sciences of the College of Arts and Sciences.

The program is based on the extensive experience that Mathematics has gained its undergraduate actuarial program as well as needs identified by specific employers. The Program Development Plan lays out a well conceived rationale and curriculum.

The MQRM program is an excellent proposed addition to the graduate degree offerings of the university that captures one of the current needs of the insurance and finance industries. As well, it has the potential to produce new revenue for the university.

In recent years, risk management has been playing a more and more important role in all areas of business practice in general, and in insurance and financial institutions in particular. Insurance and Risk Management consulting have been important components of Ohio's economy. There has been an increasing demand for high quality employees in quantitative risk management throughout the state of Ohio and the nation. The mathematics department's proposal is timely to meet this need. The proposed program is innovative and unique in combining financial and actuarial mathematics to provide a new education platform for quantitative risk management that no other higher institutions have had in the state. To my knowledge, this will be the first such program in Ohio, and one of the few in the whole nation.

The mathematics department at OSU has been running a very successful undergraduate program in actuarial science. It has been producing high quality actuaries to consulting firms and insurance companies, and is highly regarded by the business world. With its rich tradition in actuarial education, its wide connection with business, and its experience in running the Master's program in mathematical sciences, I believe that the mathematics department will deliver a very successful program in quantitative risk management.

Sincerely,

A handwritten signature in blue ink that reads "Peter March".

Peter March
Divisional Dean, Natural and Mathematical Sciences
College of Arts and Sciences

Status: PENDING

PROGRAM REQUEST
Mathematics - Quantitative Risk Management

Last Updated: Hemess, M Scott
05/19/2014

| | |
|--|--|
| Fiscal Unit/Academic Org | Mathematics - D0671 |
| Administering College/Academic Group | Arts and Sciences |
| Co-administering College/Academic Group | Arts and Sciences |
| Semester Conversion Designation | New Program/Plan |
| Proposed Program/Plan Name | Mathematics - Quantitative Risk Management |
| Type of Program/Plan | Graduate degree program |
| Program/Plan Code Abbreviation | MQRM-MS |
| Proposed Degree Title | Master of Quantitative Risk Management |

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 | | | | 36 | |
| Required credit hours offered by the unit | Minimum | | | 18 | |
| | Maximum | | | 30 | |
| Required credit hours offered outside of the unit | Minimum | | | 6 | |
| | Maximum | | | 18 | |
| Required prerequisite credit hours not included above | Minimum | | | 0 | |
| | Maximum | | | 0 | |

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 acquire and are able to apply foundational knowledge from actuarial and financial mathematics courses.
 - Students acquire and are able to apply skills and knowledge from other courses in the mathematical sciences, such as statistics, financial stochastic analysis, and computational mathematics.
 - Students will be able to quantitatively interpret and evaluate risks in insurance and finance.
 - Students will be able to effectively design, implement, and assess strategies to control such risks, based on quantitative analysis.
 - Students will be able articulate and report on their findings in a manner useful in the actuarial and financial industry work environment.

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? Yes

Does the degree program or major have an assessment plan on file with the university Office of Academic Affairs? No

DIRECT MEASURES (means of assessment that measure performance directly, are authentic and minimize mitigating or intervening factors)

Status: PENDING

PROGRAM REQUEST
Mathematics - Quantitative Risk Management

Last Updated: Hemess, M Scott
05/19/2014

Standardized tests

- National standardized examination
- Certification or licensure examinations

Classroom assignments

- Embedded testing (i.e. specific questions in homework or exams that allow faculty to assess students' attainments of a specific learning goal)

Evaluation of a body of work produced by the student

- Practicum, internship or research evaluation of student work
- Senior thesis or major project

Direct assessment methods specifically applicable to graduate programs

- Thesis/dissertation oral defense and/or other oral presentation
- Thesis/dissertation (written document)

INDIRECT MEASURES (means of assessment that are related to direct measures but are steps removed from those measures)

Surveys and Interviews

- Student survey
- Alumni survey
- Employer feedback or survey
- Student evaluation of instruction
- Student interviews or focus groups

Additional types of indirect evidence

- Job or post-baccalaureate education placement
- Student or alumni honors/recognition achieved
- Curriculum or syllabus review
- Grade review
- Comparison or benchmarking

USE OF DATA (how the program uses or will use the evaluation data to make evidence-based improvements to the program periodically)

- Meet with students directly to discuss their performance
- Analyze and discuss trends with the unit's faculty
- Analyze and report to college/school
- Analyze and report to accrediting organization
- Make improvements in curricular requirements (e.g., add, subtract courses)
- Make improvements in course content
- Make improvements in course delivery and learning activities within courses
- Periodically confirm that current curriculum and courses are facilitating student attainment of program goals
- Benchmark against best programs in the field

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

Status: PENDING

PROGRAM REQUEST
Mathematics - Quantitative Risk Management

Last Updated: Herness, M Scott
05/19/2014

Does this Program have a Pre-Major? No

Attachments

- MQRM_Dean_Letter.pdf
(Letter from the College to OAA. Owner: Kerler, Thomas)
- QRM support letter Steinmetz.pdf: Letter of support from Dean Steinmetz
(Letter from the College to OAA. Owner: Vankeerbergen, Bernadette Chantal)
- Masters Quant Risk Management.pdf: Graduate School Letter
(Other Supporting Documentation. Owner: Herness, M Scott)
- Masters Quant Risk Management2.pdf: Graduate School Letter
(Other Supporting Documentation. Owner: Herness, M Scott)
- Masters Quant Risk Management3.pdf: Graduate School Letter
(Other Supporting Documentation. Owner: Herness, M Scott)
- MathRiskConcurrence_Finance.pdf: Fisher College of Business Concurrence
(Other Supporting Documentation. Owner: Kerler, Thomas)
- math_QRM_masters_concurr_stat.pdf: Statistics Department Concurrence
(Other Supporting Documentation. Owner: Kerler, Thomas)
- MAQRM_Syllabi.pdf: Syllabi of Courses
(Other Supporting Documentation. Owner: Kerler, Thomas)
- Advising_Sheet_2014_03_31.pdf: Advising Sheet
(Other Supporting Documentation. Owner: Kerler, Thomas)
- MAQRM_PDP_edit_2014_04_08_AM.pdf: Revision April 8, 2014
(Program Proposal. Owner: Kerler, Thomas)
- MAQRM_Cover_fourth_2014_04_08_AM.pdf: Cover Letter April 8, 2014
(Other Supporting Documentation. Owner: Kerler, Thomas)

Comments

- Returned for revision. Graduate School letters attached. *(by Herness, M Scott on 03/10/2014 01:54 PM)*
- Revisions as of Feb 24 include:
 - * Revision of Learning Goals to include "action verbs" in all items.
 - * Practicum/internship & project were checked in prelim assessment plan.
 - * Course numbers of practicum, thesis work, and new courses in stochastic analysis were added to the program proposal/PDP. *(by Kerler, Thomas on 02/24/2013 10:53 AM)*
- Your learning goals should use appropriate language (action verbs) – I will send you some documents to help facilitate the development of learning goals that can then be assessed by your eventual assessment plan.

In your course list, please provide the courses associated with the masters thesis (Math 7999?). Each course that would be part of the degree program should be listed by a course number, including the proposed new course "Practicum in QRM". *(by Hadad, Christopher Martin on 02/18/2013 04:42 PM)*

Status: PENDING

PROGRAM REQUEST
Mathematics - Quantitative Risk Management

Last Updated: Hemess, M Scott
05/19/2014

Workflow Information

| Status | User(s) | Date/Time | Step |
|--------------------|-----------------------------------|---------------------|------------------------|
| Submitted | Kerler, Thomas | 02/18/2013 03:42 PM | Submitted for Approval |
| Approved | Husen, William J | 02/18/2013 03:46 PM | Unit Approval |
| Revision Requested | Hadad, Christopher Martin | 02/18/2013 04:42 PM | College Approval |
| Submitted | Kerler, Thomas | 02/24/2013 02:44 PM | Submitted for Approval |
| Approved | Husen, William J | 02/24/2013 03:49 PM | Unit Approval |
| Approved | Hadad, Christopher Martin | 02/25/2013 08:59 AM | College Approval |
| Approved | Vankeerbergen, Bernadette Chantal | 04/12/2013 03:37 PM | Ad-Hoc Approval |
| Revision Requested | Hemess, M Scott | 03/10/2014 01:54 PM | GradSchool Approval |
| Submitted | Kerler, Thomas | 04/08/2014 03:27 PM | Submitted for Approval |
| Approved | Husen, William J | 04/08/2014 03:37 PM | Unit Approval |
| Approved | Hadad, Christopher Martin | 04/08/2014 04:56 PM | College Approval |
| Approved | Hemess, M Scott | 05/19/2014 04:00 PM | GradSchool Approval |
| Pending Approval | Newhouse, Melissa Ann | 05/19/2014 04:00 PM | CAA Approval |

PROGRAM DEVELOPMENT PLAN

MASTER IN ACTUARIAL AND QUANTITATIVE RISK MANAGEMENT

A PROGRAM IN ACTUARIAL AND FINANCIAL MATHEMATICS

1. Introduction

Actuarial and Quantitative Risk Management (AQRM) deals with applications of financial mathematics and actuarial science to the management of risks. As the long term investments with various types of guaranteed returns become more and more popular, there has been an increasing demands by employers in both public and private sectors for graduates with knowledge and skills in AQRM, and new career opportunities have become available. The traditional actuarial science program mainly addresses the need in risk management in insurance, and the financial math program is usually focused on financial risk. The present program is innovative and unique in that it combines actuarial science and financial math together to prepare students with foundations in both fields so that they can address the needs of AQRM as they arise in complicated situations.

2. Vision and Goals

There have been increasing interactions between actuarial science and financial mathematics in the last a couple of decades, especially after the recent financial crisis. Pricing and hedging in insurance have posed new challenges to mathematical finance, and the development of financial mathematics has provided more opportunities to the insurance industry.

There are two types of risks: one from insurance losses and the other from the capital market. The risks related to insurance losses are studied in the traditional actuarial science, and the quantitative study of the risks from capital market is the subject of financial mathematics. As the offers in long term investments with various types of guaranteed returns become more and more popular, there has been an increasing demand for actuaries to be able to model and manage risks from the capital market perspective, and for financial mathematicians to be able to work with risks from insurance losses. This master degree program in quantitative risk management is proposed in response to the need from both academic research and industrial practice. The program is different from the traditional actuarial programs and the financial math programs in that it will provide students with opportunities in both fields, separately or in combination.

3. Curriculum

The curriculum of the program will cover important components of actuarial science and financial mathematics including financial economics, life contingencies, loss models, stochastic calculus for finance, and other topics from financial and actuarial mathematics.

There are two options to complete the program: thesis option or non-thesis option. The thesis option requires a minimum of 36 (semester) hours of course work, and a thesis with an oral exam.

The non-thesis option requires a minimum of 39 hours of course work and a comprehensive exam that will simultaneously fulfill the university master examination requirements. The latter will be a four hour long written exam. It consists of two parts of two hours each and each testing one of five areas that the student can choose from. The possible subjects are as follows:

1. Financial mathematics and economics
2. Stochastic calculus with applications in finance
3. Numerical analysis
4. Life contingencies
5. Loss models

The content will mainly be based on course materials but may also lean on content of the professional exams (below).

In accordance with university rules the examination committee will consist of two graduate faculty of whom one is the formal advisor from the mathematics program. The latter may be Dr. Ban, Dr. Guan, Dr. Overman, Dr. Falkner, or Dr. Stan (who is eligible for graduate status) all of whom have expertise on the mathematical side of these subjects. The second committee member can also be a graduate faculty from statistics or the business school. Dr. Ban will usually be a member in exams on the first two subjects and Dr. Overman for the third subject. For exams involving the fourth and fifth subject R. Evans and D. Heyer, respectively, will usually serve as added members (on a petition basis) besides the two official graduate faculty.

The exam will be administered and graded by the regular graduate faculty members. The outcome of an exam is on a pass/fail basis also to be decided by the graduate faculty members of the committee. The added members may possibly be consulted in this process. The main criterion for passing is a strong understanding and command of the tested course material that allows the candidate to apply the learned theoretical methods to real problems in finance and actuarial science a meaningful and effective way.

Results of the examinations will be reported to and monitored by the MAQRM committee (below) and the graduate studies committee. Additional offering of the exam in other semesters may be considered as the program grows in size.

The course curriculum contains 12-hour required courses, 12 to 18-hour major elective courses, and 9 to 15-hour more general elective courses. See Appendix 3 for the lists of required and elective courses comprising the program. Many of the proposed courses in the program are already, or will soon be, offered, and four new courses to be developed: a two-course sequence in stochastic calculus for finance, a topics course, and a practicum course. The topics course will cover practical situations and problems that arise in financial math, actuarial science, and numerical methods. The practicum course will cover topics and projects from real world practices.

The curriculum covers topics of all the preliminary education requirements by the professional societies, the Society of Actuary and the Casualty Actuarial Society, including the actuarial exams and Validation for Educational Experience (VEE).

We attached a concurrence letter from our Statistics Department, the only unit besides mathematics offering required or elective courses. All stipulations of the letter have been incorporated in the curriculum and our planning. Attached is also a concurrence letter from the Fischer School of Business, which confirms that there is no conflict with a degree they are planning to offer.

4. Administration and Advising

The program has been proposed and designed, and will be hosted and administered by the Department of Mathematics under auspices of the OSU Graduate School and the College of

Arts and Sciences, which supervise university academic standards, and fully support the degree program.

The curriculum includes elective courses offered by the Department of Statistics which will oversee the corresponding courses it offers. The college has expressed its support of the MAQRM program and will thus work with Statistics on required resources for the course offerings as the program grows larger.

Each student in the program will be assigned a faculty advisor and a possible mentor from the industry. A program committee will be formed initially by the current actuarial science faculty and staff, but more members will be added later. Many actuaries, financial specialists, and other practitioners have expressed strong interests to work with our new program, so we expect to have plenty of mentors from the industry to work with our students.

The program and its students will be under the supervision of the Graduate Studies Committee (GSC) of the OSU Mathematics Department. The members and chair of the GSC are appointed by the chair of the department. MAQRM students will be included in the annual evaluation of graduation of all graduate students conducted by the GSC each spring, based on academic performance data and letters submitted by advisors. At least one member of the MAQRM program committee (MAQRMP) will be involved directly in the evaluation. Suggested modifications to the program are submitted to the GSC by the MAQRMP for discussion and approval, and there will be reviews of the performance of the program once a year (at least in the beginning years) by the GSC based on summary performance reports issued by the MAQRMP.

The MAQRMP will assist the vice-chair for graduate studies in determining initial advisors and will assure that students are able to find graduate faculty members for their thesis and examination committees. These committees as well as thesis and examination topics will be approved by the GSC prior to graduation up on the recommendation of the MAQRMP. Students and advisors will be provided with advising guidelines, course offerings, program requirements, and sample schedules. Student progress on course requirements, examinations, and other indicators will be recorded and monitored through an interactive electronic system (GradCentral) which subsume the function of traditional advising sheets.

Industry mentors will co-advise students on the course selection and study plans in particular in regard to relevance for professional career planning. Although they may not serve as official members on masters committees, they will also help students in their theses and assist committees with various aspects of conducting the master examinations (for either thesis or non-thesis option).

5. Evidence and Need

As mentioned earlier, there has been an increasing need for graduate students equipped with knowledge and skill in actuarial science and financial math to meet the growing demand of AQRM. More specifically, many of our former graduate students and postdocs in math or statistics who had exposures to actuarial science or financial math have been hired by companies including Nationwide, AEP, Progressive Insurance, J. P. Morgan Chase, Capital One, Bank of America, State Auto Insurance, and several other financial institutions. We recently received several requests of cooperation at the graduate level from Nationwide Financial, Cleveland Clinic, and Progressive Insurance. The demands for graduate students in AQRM are increasing, and job opportunities are waiting for qualified students.

Another evidence of need for the proposed program is the increasing number of our own undergraduate students in actuarial science or in financial math who have continued with graduate studies upon their graduation from OSU. Our students have gone to master or Ph.D. programs in schools like Oxford, Columbia, Carnegie Mellon, Chicago, Cornell, Wisconsin, UCLA, Illinois, to just name a few. A master program in AQRM at OSU will definitely serve our students better.

There is no program in the state of Ohio which is similar to the one we are proposing. Kent State University has been offering a master program in financial engineering, but it does not have the actuarial science component and it does not meet the AQRM demands from the insurance companies and financial institutions as those mentioned above. A one-year Specialized Masters in Business – Risk Management is being developed at Fisher College of Business at OSU and Fisher also has Risk Management Tracks both in their undergraduate and graduate curriculum, but these programs approach risk management from a general business point of view and they do not cover the topics from actuarial and financial mathematics. The program we are proposing will be the first actuarial and financial math program among the higher education institutions in the state of Ohio.

6. Enrollment

The recruitment of the proposed program is targeted at undergraduate students in actuarial science, mathematics, statistics, computer science, economics, business finance, and other related fields with strong quantitative training and good communication skills. To be admitted to the program, a candidate should have an undergraduate GPA of 3.5/4.0 or better and a good score on the Graduate Record Examination (GRE). Though it is not a strict requirement, a satisfactory score in the math subject test of the GRE is strongly recommended.

The experience with our undergraduate actuarial science program has shown that the enrollment is well balanced between genders and underrepresented groups. We have also noticed that there has been an increasing enrollment of international students, especially Chinese and Korean students. We will continue and extend our efforts in recruiting in underrepresented groups, and we are expecting similar enrollment pattern in the proposed master degree program.

In order to ensure quality, the program will start small with about five to ten students, and it will grow to about twenty students per year as we gain experience.

The MAQRM degree program is in all fiscal and topical aspects clearly distinct from all other degree programs offered by the mathematics department and is thus expected to have no impact on any of them.

7. Faculty and Staff Resources, Facilities

Since we anticipate the program to start with small numbers of students, a few courses may be initially staffed by part-time lecturers with a strong background in the area. As the program grows, however, there will be a need to hire at least one regular faculty, which will be facilitated by the additional revenue that the program eventually generates.

We will invite qualified practitioners to lectures in the topics course and the practicum course. These courses will have graduate faculty as instructors of record, who will be responsible for assessment and assigning grades. Several of our former Ph.D. students or post-docs are working in QRM related fields in Columbus. They were good instructors while they were at

OSU. With their experiences in mathematical research and teaching and their practical experience, they will be excellent candidates to assist regular faculty in the instruction of our practice related courses.

There will be additional classroom needs for the new courses at an estimate of two courses per semester. Since the courses will likely be offered late in the afternoons, the chances for classroom conflicts will be minimal.

Initial composition of the MAQRM program committee:

- **Chunsheng Ban.** (Program Director, Department of Mathematics)
Role: Ban will work with business to arrange internships, industry mentors, and placement. He will be the coordinating advisor for the program. He will also oversee the stochastic calculus and financial economics courses.
- **Thomas Kerler.** (Vice Chair of Graduate Studies, Department of Mathematics)
Role: Kerler will oversee program and data management, general advising, recruitment, admission, and advertisement.
- **Jean Lafont.** (Chair of Graduate Studies Committee, Department of Mathematics)
Role: Lafont will oversee evaluation of student performance and development of program requirements through the GSC.
- **Rick Evans.** (Instructor and Mentor, Department of Mathematics)
Role: Evans will oversee the sequences in life contingencies and loss models, and will help to advise students.
- **Dan Heyer.** (Industry Advisor, Nationwide Financial)
Role: Heyer will serve as industry advisor. He will also oversee the topics course.

8. Projected Costs

The curriculum of the MAQRM program requires four new courses of 3-credit hours each. When the program starts, it will increase the enrollment of related existing courses, will need two part-time lecturers or one faculty to cover the new courses, and will need extra department resources for program managing, student advising and mentoring, advertising and recruiting, and other related matters. An estimate of the total cost is about \$335,000.

The enrollment will consist of fee-paying students. Each cohort year will have about twenty students, and there will be about forty students when the program runs in its full capacity. We are expecting that half to three fourths of the enrollment consists of out-of-state students (including international students). The tuition and fees per year (i.e. two semesters) is \$12,200.80 for Ohio resident and \$29,512.80 for out-of-state student. The estimates of the annual income from tuition and fees are

| | |
|--------------------------------------|--------------------------|
| Low End (40 in-state students): | \$488,032 |
| High End (40 out-of-state students): | \$1,180,512 |
| Expectation: | \$834,272 to \$1,007,392 |

There will be a differential fee charged to each student for enrolling into the program which will be assessed.

Therefore, the proposed program is cost-effective for the graduate school, the college of arts and sciences, and the university.

APPENDIX: ACADEMIC PROGRAM

1. Prerequisite

- Students are expected to have completed advanced calculus, calculus based probability, and elementary economics. They are also expected to have some working knowledge in a computer programming language. The equivalent OSU courses include Math 2153 (calculus), Math 4530 or Stat 4201 (probability), Economics 2001 and 2002, CS&E 1222 or 1223 (computer programming).
- Theory of interest at the level of Exam FM, an actuarial exam administered by the Society of Actuaries and the Casualty Actuarial Society, is required. The equivalent OSU course is Math 3618. If a student does not meet this prerequisite, Math 3618 can be taken during the first semester of a student's MAQRM study.

2. Requirements

- Thesis option: At least 36 credit hours of required or elective course work, a master thesis and an oral exam based on the thesis.
- Non-thesis option: At least 39 credit hours of required or elective course work and comprehensive exams, oral or written, in two areas from financial math and economics, stochastic calculus, differential equations, numerical analysis, life contingencies, or loss models.

3. Courses

Required Courses (12 credit hours)

- Financial Economics: Math 5632 (3 credits)
- Probability/Statistics Sequence: Stat 6301 and 6302 (6 credits)
- Practicum in AQRM: Math 5588 (3 credits) New Course

Elective Courses (2 or 3 sequences, 12--18 credit hours from the following list)

- Stochastic Calculus for Finance: Math 6631 and 6632 (6 credits) New sequence
- Life Contingencies: Math 5630 and 5631 (6 credits)
- Loss Models: Math 5633 and 5634 (6 credits)
- Topics in Risk Management: Math 6630 (3 credits; can be repeated for up to 6 credits) New course
- Numerical Analysis: Math 5601 and Math 5602 (6 credits)
- Master Thesis Research: Math 6999 (3--6 credits)

Other Elective Courses (9--15 credit hours from the following list)

- Real Analysis: Math 5201, 5202 (6 credits)
- Differential Equations: Math 5401, 5402 (6 credits)
- Numerical Linear Algebra: Math 5603 (3 credits)
- Regression Analysis: Stat 6450 (4 credits)
- Time Series: Stat 6550 (2 credits)
- Applied Stochastic Process: Stat 6540 (3 credits)
- Applied Multivariate Analysis: Stat 6560 (3 credits)
- Applied Survival Analysis: Stat 6605 (3 credits)
- Introduction to SAS: Stat 5740 (2 credits)

4. Sample Schedules

The schedules below provide examples for both thesis and non-thesis option, one for students with sufficient background in the theory of interest and another for students who need to take Math 3618. The credits from Math 3618 will count neither towards program requirements nor to the university's minimum hour requirement. In the tables below credits in bold face are the ones counting towards the 36 or 39 required hours.

- SAMPLE 1 (*Thesis-Option, with Math 3618 background*)

| | FALL | | SPRING | |
|--------|-----------|------------|-----------------------|------------|
| YEAR 1 | Stat 6301 | 3cr | Stat 6302 | 3cr |
| | Math 5632 | 3cr | Math 5603 | 3cr |
| | Elective | 3cr | Elective | 3cr |
| YEAR 2 | Math 6631 | 3cr | Math 6632 | 3cr |
| | Stat 6450 | 3cr | Elective | 3cr |
| | Elective | 3cr | Practicum (Math 5588) | 3cr |
| | | | Thesis (Math 6999) | 2cr |

- SAMPLE 1 (*Non-thesis-Option, starting with Math 3618*)

| | FALL | | SPRING | |
|--------|-----------|------------|-----------------------|------------|
| YEAR 1 | Math 3618 | (3cr) | Math 5631 | 3cr |
| | Stat 6301 | 3cr | Stat 6302 | 3cr |
| | Math 5630 | 3cr | Stat 6450 | 3cr |
| | Elective | 3cr | Elective | 3cr |
| YEAR 2 | Math 5632 | 3cr | Math 5634 | 3cr |
| | Math 5633 | 3cr | Stat 6550 | 2cr |
| | Elective | 3cr | Elective | 3cr |
| | | | Practicum (Math 5588) | 3cr |

| Master of Actuarial and Quantitative Risk Management 36–39 credit hours | | | | |
|--|---|--------------|--------------------------|--------------|
| Course # | Course Name | Units | Choice | Grade |
| Prerequisites | | | | |
| Math 4530 or Math 5530 or Stat 4201 | Probability Honors Probability Intro to Math Stat I | | <input type="checkbox"/> | |
| Math 3618 | Theory of Interest | | <input type="checkbox"/> | |
| Core Requirements (15 credit hours) | | | | |
| Math 5632 | Financial Economics | 3 | <input type="checkbox"/> | |
| Stat 6301 | Probability for Statistical Inference | 3 | <input type="checkbox"/> | |
| Stat 6302 | Theory of Statistical Analysis | 3 | <input type="checkbox"/> | |
| Math 5588 | Practicum in Risk Management | 3 | <input type="checkbox"/> | |
| Stat 6540 | Applied Stochastic Processes | 3 | <input type="checkbox"/> | |
| Major Elective Courses (2 or 3 sequences, 12–18 credit hours) | | | | |
| Math 5630 | Life Contingencies I | 3 | <input type="checkbox"/> | |
| Math 5631 | Life Contingencies II | 3 | <input type="checkbox"/> | |
| Math 5633 | Loss Models I | 3 | <input type="checkbox"/> | |
| Math 5634 | Loss Models II | 3 | <input type="checkbox"/> | |
| Math 5635 | Stochastic Calculus for Finance I | 3 | <input type="checkbox"/> | |
| Math 5636 | Stochastic Calculus for Finance II | 3 | <input type="checkbox"/> | |
| Math 5601 | Essentials of Numerical Methods | 3 | <input type="checkbox"/> | |
| Math 5602 | Computational PDEs | 3 | <input type="checkbox"/> | |
| Math 5637 | Topics in Risk Management | 3–6 | <input type="checkbox"/> | |
| Math 6999 | Master Thesis Research | 3–6 | <input type="checkbox"/> | |
| Other Elective Courses (6–12 credit hours) | | | | |
| Math 5201 | Introduction to Real Analysis I | 5 | <input type="checkbox"/> | |
| Math 5202 | Introduction to Real Analysis II | 5 | <input type="checkbox"/> | |
| Math 5401 | Applied Differential Equations I | 3 | <input type="checkbox"/> | |
| Math 5402 | Applied Differential Equations II | 3 | <input type="checkbox"/> | |
| Math 5603 | Numerical Linear Algebra | 3 | <input type="checkbox"/> | |
| Stat 5740 | Introduction to SAS Software | 2 | <input type="checkbox"/> | |
| Stat 6450 | Applied Regression Analysis | 4 | <input type="checkbox"/> | |
| Stat 6550 | The Statistical Analysis of Time Series | 2 | <input type="checkbox"/> | |
| Stat 6560 | Applied Multivariate Analysis | 3 | <input type="checkbox"/> | |
| Stat 6605 | Applied Survival Analysis | 3 | <input type="checkbox"/> | |

Total Credit Hours _____

Name _____ **OSU ID (name.#)** _____

Signature _____ **Date** _____

MASTER IN ACTUARIAL AND QUANTITATIVE RISK MANAGEMENT

SYLLABI

As part of the proposal of a MAQRM degree by the Department of Mathematics of the Ohio State University the following documents are included for submission:

- Course Outline for Math 5588: Practicum in AQRM
- Course Outline for Math 5633: Loss Models I
- Course Outline for Math 5634: Loss Models II
- Course Outline for Math 6630: Topics in Quantitative Risk Management
- Course Outline for Math 6631: Stochastic Calculus for Finance I
- Course Outline for Math 6632: Stochastic Calculus for Finance II

Math 5588: Practicum in AQRM

- Course Description
 - Presentations by practitioners on topics drawn from their fields of expertise
 - Presentations by students on selected topics in actuarial and financial risk management
- Objective
 - To understand problems from real practice of risk management
 - To develop skills in team working and in communication
- Prerequisite
 - Probability and statistics: Math 4530 or Math 5530H or Stat 4201, Stat 4202
 - Financial math: Math 3618, Math 5632
- Textbook
None
- Topics
 1. Problems and trends in life and property/casualty insurance
 2. Problems and trends in actuarial consulting
 3. Problems and trends in quantitative finance
 4. Business communication
 5. Other topics from risk management
- Academic Misconduct
It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but riot limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee. For additional information, see the Code of Student Conduct:
http://studentaffairs.osu.edu/pdfs/csc_12-31-07.pdf

Math 5633: Loss Models I

- Course Description

With the follow-up course Math 5634 together, this two-semester sequence introduces students to the construction and evaluation of actuarial models. The course covers topics from the professional examinations of the Society of Actuaries and the Casualty Actuarial Society.

- Objective

- To understand survival, severity, frequency and aggregate models
- To be able to calculate basic distributional quantities in these models
- To be able to identify and apply these models in applications with given data

- Prerequisite

Thorough knowledge of calculus, probability, and mathematical statistics is assumed. Students should have successfully completed courses equivalent to OSU's Math 4530 or Stat 4201, and Stat 4202.

- Textbook

"Loss Models: from data to decision" by S. Klugman, H. Panjer, and G. Willmot

- Topics

1. Basic quantities
2. Measures of risk
3. Characteristics of actuarial models
4. Continuous models
5. Discrete models
6. Frequency and severity
7. Aggregate model

- Academic Misconduct

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Math 5634: Loss Models II

- Course Description

A continuation of Math 5633. Together with Math 5633, this two-semester sequence introduces students to the construction and evaluation of actuarial models. The course covers topics from the professional examinations of the Society of Actuaries and the Casualty Actuarial Society.

- Objective

- To understand survival, severity, frequency and aggregate models
- To be able to calculate basic distributional quantities in these models
- To be able to identify and apply these models in applications with given data

- Prerequisite

Math 5633.

- Textbook

“Loss Models: from data to decision” by S. Klugman, H. Panjer, and G. Willmot

- Topics

1. Point and interval estimation
2. Complete data
3. Modified data
4. Parameter estimation
5. Estimation for discrete distributions
6. Bayesian estimation
7. Simulation
8. Credibility

- Academic Misconduct

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Math 6630: Topics in Quantitative Risk Management

- Course Description

This course will cover some topics from quantitative risk management that are not covered in the other standard courses. The course will expose students to broader and deeper insights into actuarial and financial risks and how to manage these risks.

- Prerequisite

Math 5630, 5631, 5632

- Textbook

None

- Topics

Possible topics include

1. Variable annuities with guarantees
2. Computational issues
3. Interest rate modeling
4. Measure of risk
5. General linear model in insurance
6. Credit risk
7. Monte Carlo simulation

- Academic Misconduct

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Math 6632: Stochastic Calculus for Finance II

- Course Description
Exotic options, American derivatives, change of numéraire, term-structure of interest rate, jump processes
- Objective
The 6631-6632 sequence is to provide students with a solid mathematical foundation for application of stochastic calculus in financial problems.
- Prerequisite
Probability: Math 6631
- Textbook
“*Stochastic Calculus for Finance II Continuous-Time Models*” by Steven E. Shreve
- Topics
 1. Knock-out options
 2. Lookback options
 3. Asian options
 4. Stopping times
 5. American put and call options
 6. Numéraire
 7. Foreign and domestic risk-neutral measures
 8. Forward
 9. Affine-yield models
 10. Heath-Jarrow-Morton model
 11. Forward LIBOR
 12. Poisson process, compound Poisson process
 13. Jump process
- Academic Misconduct
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October 2, 2013

To: Chunseng Ban
From: Karen Hopper Wruck and Ingrid Werner
RE: Letter of support from Fisher College

Thank you for the materials regarding your proposed Master in Actuarial and Quantitative Risk Management. We appreciate you taking the time to share these materials and discuss them with us.

As you are aware, we plan to propose a Specialized Master in Business — Risk Management Track sometime within the next academic year. Our program will target a different student audience and contain very different, but complimentary content and materials.

We concur with the offering of the proposed Master in Actuarial and Quantitative Risk Management with the understanding that we can rely on your timely review and support of our degree as it comes to the proposal stage.

As we discussed in our meetings, should you see opportunities for collaboration between our faculties as our programs develop, please do not hesitate to reach out and we will do the same.

Office of the Dean

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Peter F. Craigmile
Associate Professor
Tel: (614) 292-0291
pfc@stat.osu.edu

September 10, 2013

Department of Mathematics,
Division of Natural and Mathematical Sciences
College of Arts and Sciences

Dear Prof. Chunsheng Ban

The chairs and curriculum committee in the Department of Statistics have looked over your proposal for the Master in Quantitative Risk Management program. We give concurrence for this degree program subject to the following stipulations.

1. We note that Stat 6302 is a statistical theory course and not a probability course. We would be uncomfortable with Mathematics teaching a replacement for this course. Please note that we have designed our Stat 6301/Stat 6302 to be one sequence. The audience is intended primarily for our Masters of Applied Statistics program; the second course requires the first.
2. Currently we can handle about 5 new students a year in Stat 6301/6302. If the numbers in these classes were higher than this, some cost sharing would need to be negotiated so that we can keep up the level of quality teaching for our Masters of Applied Statistics program.
3. The time series course, Stat 6550, is currently taught every second year. Again with appropriate external funding this could be increased to every year.
4. We suggest that Stat 6605 (Applied Survival Analysis), a course concerning the statistical methods appropriate for life analysis, might be appropriate to the study of quantitative risk, and could be considered as an elective.

Sincerely,

A handwritten signature in black ink that reads "P Craigmile".

Peter F. Craigmile, Ph.D.
Curriculum Chair, Department of Statistics.

cc: Mark Berliner, Chair, Department of Statistics
cc: Bill Notz and Elizabeth Stansy: Vice chairs, Department of Statistics