Fiscal Unit/Academic Org	Mathematics - D0671
Administering College/Academic Group	Arts and Sciences
Co-adminstering 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)

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

Does this Program have a Pre-Major? No

Attachments

- MQRM_Dean_Letter.pdf

  (Letter from the College to OAA. Owner: Kerler,Thomas)

- ASC_Submit_MQRM_PDP.pdf

  (Program Proposal. Owner: Kerler,Thomas)

- ASC_Submit_MQRM_PDP_rev_2013_02_24.pdf: Revision Feb 24, 2013

  (Program Proposal. Owner: Kerler,Thomas)

Comments

- 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)*

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
Pending Approval	Fink,Steven Krieger Herness,M Scott	02/25/2013 08:59 AM	GradSchool Approval
Pending Approval	Vankeerbergen,Bernadette Chantal	03/07/2013 03:12 PM	Ad-Hoc Approval

College of Arts and Sciences

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230 N. Oval Mall
Columbus, OH 43210

Phone (614) 292-8908
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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,

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

Department of Mathematics
Mathematics Building MA 102
231 West 18th Avenue
Columbus, OH 43210

Phone (614) 292-5252
Fax (614) 292-1479
E-mail kerler@math.osu.edu

Master of Quantitative Risk Management

Submitted to the College of Arts and Science

Dear Colleagues,

Please find attached the Program Development Plan (PDP) for the MQRM degree that the Division of Mathematical and Natural Sciences plans to submit to the Graduate School and Ohio Board of Regents.

The Rationale for the program has been explained in Dean March's letter and is further laid out in the Sections *Vision and Goals* as well as *Evidence and Need* in the following PDP.

You will find the list of Semester Courses in the Appendix *Academic Program* at the end of the PDP.

Since this is a new program we are not submitting materials pertaining to quarter to semester conversion.

Please do not hesitate to contact us with any questions or concerns you may have.

Sincerely,

Thomas Kerler
Vice Chair for Graduated Studies
Department of Mathematics

Program Development Plan

Master in Quantitative Risk Management

A Program in Actuarial and Financial Mathematics

Introduction

Quantitative Risk Management (QRM) deals with applications of financial mathematics and actuarial science to the management of financial and insurance 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 QRM, 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 QRM as they arise in complicated situations.

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 the mathematical theory of 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 financial market. The risks related to insurance losses are studied in the traditional actuarial science, and the quantitative study of the risks from financial market is the subject of financial mathematics. As the offers in long term investments with various type 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 financial market perspective, and for financial engineers 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.

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 comprehensive exams in two major areas. The curriculum contains 12-hour required

courses, 12 to 18-hour major elective courses, and 9 to 15-hour more general elective courses. See Appendix for the schedule of 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).

Administration

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, the Department of Computer Science and Engineering, and the Department of Finance. These departments will oversee the corresponding courses they offer.

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.

Evidence and Need

As mentioned earlier, there has been an increasing need for graduate students equipped with knowledge and skill in actuarial science, financial math, and quantitative finance to meet the growing demand of QRM. 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 QRM 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 QRM 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 QRM demands from the insurance companies and financial institutions as those mentioned above. The program we are proposing will be the first one among the higher education institutions in the state of Ohio.

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.

Faculty and Staff Recourses, Facilities

Since the program will start small, there will be no need to add additional faculty and staff in the beginning instead of hiring a couple of part-time lecturers. However, there will be a need to add at least one faculty as the program grows and generates income. We will invite qualified practitioners to teach the topics course and the practicum course. Several of our former Ph.D. students or postdocs 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 teach 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 MQRM program committee:

- Thomas Kerler, Department of Mathematics
  Role: Vice Chair of Graduate Studies.

Kerler will oversee the whole program including recruitment, admission, and advertisement.

- Janet Best, Department of Mathematics
  Role: Chair of Graduate Studies Committee.
  Best will oversee the general administration of the program and management of students.
- Chunsheng Ban, Department of Mathematics
  Role: Program Director
  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.
- Rick Evans, Department of Mathematics
  Role: Instructor and Mentor
  Evans will oversee the sequences in life contingencies and loss models, and will help to advise students.
- Dan Heyer, Nationwide Financial
  Role: Industry Advisor
  Heyer will serve as industry advisor. He will also oversee the topics course.

Projected Costs

The curriculum of the MQRM 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

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 MQRM study.

Requirements

- Thesis option: At least 36 credit hours of course work, a master thesis and an oral exam based on the thesis.
- Non-thesis option: At least 39 credit hours of 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.

Courses

Required Courses (12 credit hours)

- Financial Economics: Math 5632 (3 credits)
- Probability/Statistics Sequence: Stat 6301 and 6302 (6 credits) (or a master level probability sequence offered by the math department)
- Practicum in QRM: Math 6191.02 (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)

- Introduction to SAS: Stat 5740 (2 credits)
- Computer Science: CS&E 6331, 6341 (6 credits)
- Corporate Finance and Investment: Fin 7212 & 7213, 7220 & 7223 (6 credits)

Sample Schedules

- Sample 1

	Fall	Spring
Year 1	Stat 6301, Math 5632, Electives	Stat 6302, Stat 6540, Math 5603, Electives
Year 2	Math 6631 Stat 6450, Electives	Math 6632 Math 6191.02, Electives

- Sample 2

	Fall	Spring
Year 1	Math 3618, Math 5630 Stat 6301, Electives	Math 5631, Stat 6302, Stat 6540, Electives
Year 2	Math 5632, Math 5633, Stat 6450, Electives	Math 5634, Stat 6550, Math 6191.02, Electives

Advanced students who have taken some of the MQRM required courses during their undergraduate study can finish the master degree in less than two years.