

Foundations of Quantitative Risk Management

ACTSC 964, Winter 2026

Instructor:	Ruodu Wang
Email:	wang@uwaterloo.ca
Office:	M3 3122
Lectures:	MW 4:00–5:20 pm, M3 4206
Course website:	https://learn.uwaterloo.ca/
Target audience:	Ph.D. students and Master’s students in Actuarial Science, Quantitative Finance, or Statistics

Objectives

At the ASTIN meeting in 2005, Professor P. Embrechts (ETH Zurich, Switzerland) referred to those actuaries working in enterprise risk management as *actuaries of the fourth kind*. The knowledge of risk management becomes crucially important for modern actuaries.

In this course, we study fundamental concepts in quantitative risk management (QRM). Topics include: basics of risk management and regulation, risk measures, financial time series, extreme value theory, copulas, multivariate distributions, risk aggregation and allocation, and applications. This course should be treated as a mathematical or statistical course.

The aim of the course is to build a good understanding of the foundations of QRM and its practice.

The course contents have a considerable overlap with those of ACTSC445/845, with a different focus. If you have already taken 445/845, I recommend you not to take this course, and to take some more specialized courses instead.

Office hours

- Every Monday 3:00–4:00 I will host office hours in my office. Outside this time, you can book an appointment with me by email.

References

The course slides and other materials are available on Learn.

[1] There is a main reference book

- (i) McNeil, A. J., Frey, R. and Embrechts, P. (2015). *Quantitative Risk Management: Concepts, Techniques and Tools*. Revised Edition. Princeton, NJ: Princeton University Press.

[2] Materials are also available on a third-party website

- (ii) QRM Tutorial: <http://qrmtutorial.org>.

[3] There is an exercise book available (also uploaded to Learn)

- (ii) QRM Exercises: <https://www.qrmtutorial.org/exercises>.

[4] Recommended reading

- (iv) Föllmer, H. and Schied, A. (2016). *Stochastic Finance*. 4th edition, De Gruyter.

[5] Large language models (AI): they can make mistakes, but they are quite knowledgeable on the content.

Test materials are based on lecture notes. Some chapters in the lecture notes will not be discussed, and this will be made clear during the lectures.

Codes

All codes will be in R (the main coding language for statisticians). If you prefer another language such as Python, you will have to create your own codes for all exercises and tasks. Python is more popular in the financial industry. Nowadays with the help of AI, coding becomes easy.

Midterms

Two (small, closed-book) midterms are planned. Tentative schedule:

- (1) February 23 (M), 1.5 hours (week 7)
- (2) April 1 (W), 1.5 hours (week 12)

Exams will be given in person during the lecture time.

Data implementation project

At the end of each chapter (from Chapters 3-7), I will assign a data implementation task to one student or students in a group (depending on the number of total enrolled students). The task is relatively simple. It involves applying the learned methods to a new dataset or some datasets and a short presentation.

- The projects are at a level such that AI can probably do it well. You will need to be able to explain it to show that you understand everything.

Essay and presentation

Towards the end of the term, each student will write an essay about recent developments of a specific QRM topic based on reading one or a few research papers. The students will also present a short presentation of their essay. Depending on the number of students in the class, the students may work in groups.

- Do not let AI do the work. AI is allowed to use to help, like providing information or polishing writing.
- AI should only be used to make human understand the content better, not worse.
- Presentations will take place in week 13, at a time to be agreed by all.

Course Evaluation Breakdown

- (1) Midterm #1, 20%;
- (2) Midterm #2, 20%;
- (3) Chapter project, 20%;
- (4) Essay, 20%;
- (5) Presentation of essay, 20%.

Tentative Schedule

	Weeks	Topics	Chapter
Part I	1-2	Introduction to QRM	
		Risk in perspective	1
		Basics concepts in risk management	2
Part II	3-7	Methods for univariate risks	
		Empirical properties of financial data	3
		Financial time series	4
		Extreme value theory	5
Part III	8-12	Methods for multivariate risks	
		Multivariate models	6
		Copulas and dependence modeling	7
		Risk aggregation and allocation	8

Policy on Intellectual Property

Students should be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as:

Lecture content, spoken and written (and any audio/video recording thereof); Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides); Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner). Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository).

Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights.

Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).

Relevant University Policies:

[Policy 71 - Student Discipline](#) [Policy 73 - Intellectual Property Rights](#)