Worcester Polytechnic Institute

MA 575: Market and Credit Risk Models and Management
Department of Mathematical Sciences
Spring 2023

Instructor:
Professor Marcel Blais
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508-831-5677
Unity 286
Zoom Room ID: 346 8778 8225

Class: Tuesdays and Thursdays,   4pm-5:20pm,   Stratton Hall 203

Textbooks (Not Required):

- *Quantitative Risk Management. Revised Edition*, by Alexander McNeil, Rudiger Frey, & Paul Embrechts, ISBN 978-0-691-16627-8
- *Risk Management and Financial Institutions,* by John C. Hull, ISBN 978-1-118-26903-9

Course Delivery:

This course is offered in-person on the WPI campus and will be completely accessible online. The in-person meetings will be recorded via Echo-360 classroom capture and posted on the course Canvas site.

- The Echo360 materials can be used by students who may need to transition to remote learning due to COVID-19 issues.

All resources & course assignments will be posted in the Modules section of the Canvas course webpage. The Modules section organizes the course content chronologically. All deliverables for the course will appear in the Modules section.

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Course Description:

The objective of the course is to familiarize students with the most important quantitative models and methods used to measure and manage financial risk, with special emphasis on market and credit risk. The course starts with the introduction of metrics of risk such as volatility, value-at-risk, and expected shortfall and with the fundamental quantitative techniques used in financial risk evaluation and management. The next section is devoted to market risk including volatility modeling, time series, non-normal heavy tailed phenomena, and multivariate notions of codependence such as copulas, correlations, and tail-dependence. The final section concentrates on credit risk including structural and dynamic models and default contagion and applies the mathematical tools to the valuation of default contingent claims such as credit default swaps, structured credit portfolios, and collateralized debt obligations.

Prerequisite Material:
Multivariable calculus, linear algebra, calculus-based probability, and introductory statistics are required. Basic knowledge of finance is helpful but not necessary.

Additional References:
- *Statistics and Finance: An Introduction*, by David Ruppert, ISBN 0-387-20270-6 (available as an eBook in the Gordon Library).
- *Statistics and Data Analysis for Financial Engineering with R Examples*, by David Ruppert & David S. Matteson, ISBN 978-1-4939-2613-8 (available as an eBook in the Gordon Library).

Learning Outcomes:
By the completion of this course, learners will be able to:
- Model financial portfolio loss distributions
- Compute different measures of risk for financial portfolios that include stocks, bonds, and options
- Compute portfolio value-at-risk and expected shortfall using a variety of different models
- Use standard market risk management models to manage the risk of a simulated portfolio through a real-world brokerage
- Use the Merton Model to compute probabilities of default
- Use copula models to model default scenarios and price credit risky assets, such as credit default swaps

Communication:
The primary interface for communication with the instructor will be email, the Canvas course website, office hours, & Piazza. All information about the course will be maintained on the course web page in WPI's Canvas system.

Check your *WPI* email daily.

The use of Piazza in Canvas is *strongly* encouraged for discussion with the instructor and peer students. It provides a forum where students can post questions anonymously if preferred.

Students can expect a response to email questions within 24 hours on weekdays and within 48 hours on weekends.

Office Hours:
These are interactive sessions with the instructor that will be managed in the Canvas course calendar & will be held either online using Zoom or in-person. Students are *strongly* encouraged to attend office hours.

Course Approach:
This is a semester-long course.
- Each week begins on Monday at 6am US Eastern Time and ends on the following Sunday at 11:59pm US Eastern Time.
- The Canvas course webpage will be used to manage all aspects of the course. Content will be managed primarily in the announcements, modules, assignments, calendar, & Piazza sections of the Canvas page. The modules section contains all asynchronous lecture videos and all assignments in the order in which they should be completed.
- Each week the course will consist of:
  o Two in-person meetings as per the course schedule
  o Office hours
  o At most one written homework assignment submission or project assignment submission
- All written homework will be submitted in a *single-file* PDF upload to Canvas.
- There will be several projects. Students are **required to work in teams** on projects and to submit professional quality project reports, complete with formal references & citations.
  o Project teams will formally present their course project work.

Course Requirements:

1. **Assignments**
   There are two primary assignment categories for this course:
   - **Written Homework**
     These assignments involve handwritten solutions to problems. Solutions should be second draft and thoroughly demonstrate solutions and derivations, including justifications of steps. These assignments are to be submitted as scanned PDF files in Canvas. Each assignment should be submitted as *one* PDF file.

     Students are encouraged to discuss the homework problems with other students & in discussions on Piazza, but all homework assignments must be completed, written, and submitted independently.

Written Homework Assignment Rubric:

Each homework problem is graded out of 10 points according to the criteria below:

Grade	
10	Completely correct, clear, & thorough write-up of problem solution, citing appropriate rules & theorems where appropriate. Quality is neat and easily readable.
9	Correct, clear, & thorough write-up of methodology & problem solution, citing appropriate rules & theorems where appropriate, with 1 minor mistake or omission. Quality is neat and easily readable.
6-8	Mostly correct write-up of methodology & problem solution with a few minor mistakes or omissions. Quality is neat and readable.
2-5	Incorrect solution. Partial credit is given according to key insights for the problem. Quality is readable.
0-1	Little to no work shown, giving only answers.

- ○ **Projects**

  These constitute the bulk of the work for the course. Students will work in teams on course project work, maintaining the same project team for all course projects. Each major topic for the course will have a project component.

  These projects are similar to tasks one would be assigned as a quantitative analyst in an industry portfolio management role. Real data will be used to implement models covered in class in a real-world setting.

  Students are required to compose professional quality project reports for each project assigned. Each project report should

  - ▪ Be structured using sections or chapters.
  - ▪ Include sections for introduction, background, methodology, data, implementation, results, and conclusions. The conclusions sections should be thorough and contain many insights and reflections on the work.
  - ▪ Include visual representations of the models and results, such as graphs, tables, histograms, and charts.
  - ▪ Include a formal references section with formal citations using MLA format to those references where appropriate. Note that **any** work that is not the students' own original work **must be properly cited**. WPI's policies on citations can be found here: https://libguides.wpi.edu/friendly.php?s=citingsources

  Examples of quality project reports can be provided upon request.

3. **Exams**

   Midterm Exam   Thursday, March 2   In Class

4. **Presentations**

   Each student team will present course project work to the instructor / the class.

5. **Late Work Policy**

   Extensions for assignments may be granted on a case-by-case basis. If you feel like you need an extension on an assignment, I strongly encourage you to communicate with me about this as early as possible. Reasonable extension requests will be granted. Late assignments without approved extensions will receive a grade of zero.

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POLICIES

Grading Policy:

The numerical course grade will be determined scheme below:

	Weight
Homework Average	30%
Project Work	40%
Midterm Exam	30%

Each homework grade will be converted to a percentage, and then those percentages are averaged to compute the homework average.

Final course letter grades are based on a student's performance as follows:

Letter Grade	Percentage
A	90 - 100
B	80 - 89
C	70 - 79
D	60 - 69
F	0 - 59

The instructor may adjust these grade cutoffs at the end of the course, but such an adjustment can only happen in the students' favor. For example, the minimum score for a grade of B could be decreased from 80 to 79, but it would never increase above 80.

Course incompletes may be granted if the major part of the course is completed; however, no additional credit can be given for missed work beyond the end of the course. In addition, in the case of an incomplete, the student is responsible for handing in the final work within the WPI required timeframe of one (1) year. After this time, an incomplete grade changes to a failing grade.

Accessibility Services:

Students with approved academic accommodations should plan to submit their *accommodation* letters through the *Office of Accessibility Services Student Portal*. Should you have any questions about how accommodations can be implemented in this particular course, please contact me as soon as possible. Students who are not currently registered with the Office of Accessibility Services (OAS) but who would like to find out more information regarding requesting accommodations, documentation guidelines, and what that all entails should plan to contact them either via email *AccessibilityServices@wpi.edu* or via phone (508) *831-4908.*

Mental Health:

We are embarking on this course during a difficult time, one during which many are experiencing mental health issues. As your course instructor, I am invested in your success in this course and in your well-being, and I will support you to help you succeed.

Mental health challenges, including significant stress, anxiety, mood changes, excessive worry, or problems with eating and/or sleeping can interfere with learning. The source of issues like these might be related to your course work; if so, please meet with me to discuss these issues.

WPI provides mental health services to support the well-being and academic success of students. The Student Development & Counseling Center (*SDCC).* offers free, confidential services to help you manage personal challenges.

In the event I suspect you need additional support, I will express my concerns and the reasons for them and remind you of resources that might be helpful to you. It is not my intention to know the details of what might be bothering you, but simply to let you know I am concerned and that help, if needed, is available.

Getting help is a smart and courageous thing to do -- for yourself and for those who care about you.

Academic Integrity:

You are expected to be familiar with the *WPI Academic Integrity Policy,* which can be found here. Consequences for violating the Academic Honesty Policy range from earning a zero on the assignment, failing the course, or being suspended or expelled from WPI.

Common examples of violations include:

- Copying and pasting text directly from a source without providing appropriately cited credit
- Paraphrasing, summarizing, or rephrasing from a source without providing appropriate citations
- Collaborating on individual assignments
- Turning in work where a good portion of the work is someone else's, even if properly cited

This syllabus is subject to change at the professor's discretion.