

**MFIN 706 Computational Finance**  
**DeGroote School of Business McMaster University**  
**Course Outline 2023**

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**INSTRUCTOR AND CONTACT INFORMATION**

Instructor: Mehmet Beceren, Ph.D.

Email: [becerenm@mcmaster.ca](mailto:becerenm@mcmaster.ca)

TAs: Ruinan Liu

[liu1006@mcmaster.ca](mailto:liu1006@mcmaster.ca)

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**COURSE OBJECTIVE:** The objective of MFIN 706 is to introduce key computational methods and practical resources that are widely used in contemporary finance professions. The coursework focuses on hands-on data analysis applications and coding. Additionally, the students gain perspectives on the latest developments in the Fintech sector.

**Method and Scope:** The course is designed to guide the students through a set of practical problems and projects that are done on a computer programming environment. There is no requirement for prior coding experience, however students are expected to dedicate time to build programming and data analysis skills throughout the term. Mathematical and financial concepts will be briefly discussed and explained in class. Then, related programming and data resources will be presented.

The key learning method will be hands-on work with data analysis and coding tools. Students are expected to employ computational resources to deliver solutions to selected problems in areas such as risk analysis, portfolio construction, strategy back-testing, optimization, derivative pricing and scenario simulation. There will be weekly assignments and a term project.

Students are also expected to raise their level of knowledge on recent developments in global financial markets. It is important for the Master of Finance students to develop a background on the policy, political economy and market developments.

Quantitative methods become more powerful when they are combined with the understanding of the qualitative (social, political historical etc.) context.

## COURSE DESCRIPTION

Topics of study will cover common quantitative methods used in portfolio construction, iterative optimization, numerical simulation methods, measures of risk, derivative pricing, option trading, factor-based risk models, quantitative strategy back-testing, yield curve fitting, interest rate models, and credit risk models, along with selected topics from machine learning algorithms, Robo-Advisory infrastructure and Asset-Liability Management practices. The lectures will also touch on recent developments in Fintech sector.

This course is designed to improve applied quantitative skills of students. Open-source coding will be the primary tool of learning. The focus will be to develop data analysis and programming capabilities. MFIN 706 students will have an opportunity to use their theoretical knowledge and computer skills to work on various projects.

**Timely, neat, and coherent work will be rewarded in a 'business-like' setting.** Untidy, unclear, and delayed delivery will not be accommodated.

The main programming tools will be **R – RStudio (primary) and Python – Jupyter Notebooks (secondary)**.

R programming language provides a free, open-source development environment with many powerful tools. MS Excel will also be handy. Bloomberg and Refinitiv (if available) will be used as data sources, and market information platform. An account for Wharton Research Database (WRDS) through the library will be set up to access historical financial data as well.

Additionally, current developments in global financial markets and topical business cases will be mentioned and discussed during lectures.

## COURSE MATERIALS AND READINGS

**There is no required textbook.**

Suggested reference text books are as follows.

- **R Programming and Its Applications in Financial Mathematics** by *Shuich Ohsaki, J. Ruppert-Felsot, D. Yoshikawa, CRC Press, 2018*
- **Computational Finance – An Introductory Course with R**, by *Argimiro Arratia, Atlantis Press*
- **Active Portfolio Management**, by *Richard Grinold and Ronald Kahn, McGraw Hill*
- **An Introduction to Statistical Learning with Applications in R**, by *Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani*
- **Handbook of Financial Risk Management**, by *N.H Chan, H.Y. Wong*
- **Python for Finance Cookbook**, by *Eryk Lewinson, 2020*
- **Mastering Pandas for Finance**, by *Michael Heydt, 2015*
- **Financial Risk Management and Financial Institutions** by *John C. Hull, John Wiley & Sons*

## COURSE SCHEDULE MFIN 706

### Approximate Course Program:

Broad Topic and Week	Specific Topics of Discussion
<p><b>Week # 1</b></p> <p><b>Introduction: Computational Applications, Course Logistics, Fintech Overview, Simple Numerical Simulations</b></p>	<p>Programming and Data Logistics: RStudio IDE tips and examples, Python/Anaconda/Spyder/ Jupyter Notebooks</p> <p>Fields of Computational Finance: Summary of key topics and discussion of projects</p> <p>Simulations of single and multiple correlated stochastic processes</p> <p>Robo-Advisory infrastructure and examples</p>
<p><b>Week # 2</b></p> <p><b>Stochastic Processes and Simulation Examples, Robo-Advisory Examples</b></p>	<p>Robo-Advisor Examples: Wealthfront, OpenInvest, Wealthsimple</p> <p>Robo-Advising Process: From data feed to client front-end processes</p> <p>Examples of stochastic process simulations</p> <p>APT models review, Single-factor and multi-factor models Estimation of risk exposures and covariance matrices</p> <p>Factor-based investment products and portfolio selection</p>
<p><b>Week # 3, 4</b></p> <p><b>Quantitative Investing, Strategy Design, Hedge Fund Applications</b></p>	<p>Back-testing simple factor models and rule-based portfolios Quantitative portfolio strategies and hedge fund examples: AQR, Bridgewater, Renaissance etc.</p> <p>Uses and abuses of back-testing and computational strategies in asset management</p>
<p><b>Week # 4, 5</b></p> <p><b>Machine Learning Applications in Alpha-Modeling, Statistical Learning and Pattern Recognition Basics</b></p>	<p>Machine Learning, Introduction to programming tools &amp; resources in R and Python</p> <p>ML applications in factor research and quantitative investing practices</p> <p>Limits and fallacies about machine learning in finance</p>
<p><b>Week # 5,6</b></p> <p><b>Interest Rate and Yield Curve Models</b></p>	<p>Stochastic Interest Rate Models &amp; Yield Curve Models Yield Curve Analysis: PCA, curve fitting and simulation examples</p>

	Mid-term team project discussions
<b>Week # 7</b> <b>Credit Risk</b>	Credit Risk, Correlation Risk, Default Risk and Bond Portfolio Simulations  Options and Derivatives Review
<b>Week #8</b> <b>Numerical Methods in Equity Option Pricing</b>	Numerical Methods in Equity Option Pricing and Trading Delta & Gama Hedging Examples Exotic Options Swaps and Swaption Pricing Examples Structured products examples
<b>Week #9</b> <b>Portfolio Optimization</b> <b>Index Tracking</b>	Optimization with nonlinear risk and allocation constraints Search algorithms Curve fitting and index tracking examples
<b>Week #10</b> <b>Numerical Simulations of Multi-Asset Portfolio Risk, Short-Term &amp; Long-Term Scenario Projections</b>	Short-term scenario examples with Multi-Asset Portfolios Monte-Carlo techniques, Var-Cov Assumptions  Asset-Liability Management and Long-Term Economic Scenarios
<b>Week #11</b> <b>Discussion on AI and Fintech Developments</b>	Review of Statistical Learning, Big Data and Fintech Limits to Usefulness of Data and Importance of Human Context Term-End Project Conclusions
<b>Week # 12</b> <b>Project Presentations and Conclusion</b>	Presentations and conclusion

### EVALUATION GUIDELINE

<b>Weekly 8 Assignments</b> <i>(with different weightings according to difficulty level)</i>	<b>65%</b>
<b>Term Project</b>	<b>35%</b>
<b>Total</b>	<b>100%</b>

Late assignments will not receive full mark. A significant discount will be applied according to the severity of delay.

## **Communication and Feedback**

Students who wish to correspond with instructors or TAs directly via email must send messages that originate from their official McMaster University email account. This protects the confidentiality and sensitivity of information as well as confirms the identity of the student.

Emails regarding course issues should NOT be sent to the Area Administrative Assistants.

Instructors are required to provide evaluation feedback for at least 10% of the final grade to students prior to Week #9 in the term. Instructors may solicit feedback via an informal course review with students by Week #4 to allow time for modifications in curriculum delivery.

## **ACADEMIC INTEGRITY**

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty.

For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at:

[www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity)

The following illustrates only three forms of academic dishonesty: 1. Plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained. 2. Improper collaboration in group work. 3. Copying or using unauthorized aids in tests and examinations

## **Missed Mid-Term Examinations / Tests / Class Participation**

Please do not use the online McMaster Student Absence Form (MSAF) as this is for Undergraduate students only. The MBA program will not accept an MSAF.

When students miss regularly scheduled term work which contributes 10% or more to the final grade, for legitimate reasons as determined by the Student Experience – Academic Office (SEAO), the activity necessary to compensate for the missed work will be determined by the course instructor. The compensatory activities assigned will vary with the nature of the course and the missed requirement. They include, but are not restricted to, an alternative assignment, a rescheduled midterm exam, or re-

weighting the marks for the missed component to other mark components. Documentation explaining such missed work must be provided to the SEAO within five (5) working days of the scheduled date for completion of the work.

Acceptable reasons for missed work, along with the Petition for Missed Term Work and the MBA Student McMaster University Student Health Certificate, can be found on the DeGroot MBA Student website ([mbastudent.degroot.mcmaster.ca](http://mbastudent.degroot.mcmaster.ca)). Please direct any questions about acceptable documentation to the MBA Academic Advisors ([askmba@mcmaster.ca](mailto:askmba@mcmaster.ca)).

University policy states that a student may submit a maximum of three (3) Petition for Missed Term Work per academic year, after which the student must meet with the Director of the program.

If term work is missed without an approved reason, students will receive a grade of zero (0) for that component.

### **Missed Final Examinations**

Students must be available for the duration of the posted exam period regardless of their personal exam schedule. This is to ensure student availability throughout the entire exam period in the event that an exam must be rescheduled due to unforeseen circumstances (university closure, power outage, storm policy, etc.). A student who misses a final examination without valid reason will receive a mark of 0 on the examination.

Students who have missed a final exam for a valid reason can apply to the SEAO to write a deferred examination by submitting an Application for Deferring a Final Exam with supporting documentation. The application must be made within five days of the scheduled exam.

The Application for Deferring a Final Exam and the MBA Student McMaster University Student Health Certificate can be found on the DeGroot MBA Current Student website ([mbastudent.degroot.mcmaster.ca](http://mbastudent.degroot.mcmaster.ca))

Deferred examination privileges, if granted, are normally satisfied during the examination period at the end of the following semester. In select cases, the deferred examination may be written at a time facilitated by the SEAO and agreed to by the course instructor.

Requests for a second deferral or rescheduling of a deferred examination will not be considered.

### **STUDENT ACCESSIBILITY SERVICES**

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or email [sas@mcmaster.ca](mailto:sas@mcmaster.ca). For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities:

<http://www.mcmaster.ca/policy/StudentsAcademicStudies/AcademicAccommodationStudentsWithDisabilities.pdf>

### **ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)**

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request, including the dates/times needing to be accommodated and the courses which will be impacted, to their Faculty Office normally within 10 days of the beginning of term or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

### **POTENTIAL MODIFICATION TO THE COURSE**

The instructor reserves the right to modify elements of the course during the term. There may be changes to the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

### **ACKNOWLEDGEMENT OF COURSE POLICIES**

Your enrolment in MFIN 706 will be considered as implicit acknowledgement of the course policies outlined above, or of any other that may be announced during lecture and/or on A2L. It is your responsibility to read this course outline, to familiarize yourself with the course policies and to act accordingly. Lack of awareness of the course policies cannot be invoked at any point during this course for failure to meet them. It is your responsibility to ask for clarification on any policies that you do not understand.