NYU TANDON SCHOOL OF ENGINEERING

FINANCE & RISK ENGINEERING

FRE-GY 6083
Quantitative Methods in Finance

Instructor Information

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Course Information

- FRE-GY 6083, section I2
- Quantitative Methods for Finance
- This course focuses on the art and science of building models of processes that occur in business, economics, and finance. These may include models of interest rates, derivative securities, or behavior of asset prices. These models can be solved by using techniques of modern probability and stochastic processes, which constitute the mathematical foundation. We do not attempt to cover the spectrum of model types and modeling methodologies; rather, the focus is on models that can be expressed in equation form, relating variables quantitatively.
- Course prerequisites: knowledge in univariate and multivariate calculus, linear algebra, basic probability and statistics.
- Section I2: Thu 11:00am–01:30pm
- Section I2: Jacobs Hall Rm. 214

Course Overview and Goals

This course gives a rigorous introduction to quantitative models in finance. The material covered is part of the common body of knowledge shared by quants in the financial industry.
This course also constitutes a foundation for more advanced or specialized courses, for example in the areas of stochastic calculus and option pricing, portfolio management, computational finance, credit risk modelling, algorithmic trading, and data science.

Upon completion of this course, students will be able to:

- implement existing model-based methods in financial engineering.
- think critically about models and their underlying assumptions in financial engineering.
- design an original model.
- take more advanced courses in quantitative modelling.

Course Requirements

Class Participation

Students are expected to attend classes and participate actively. They should work through the course notes ahead of the lecture and prepared to ask questions on the material during the lecture.

Assignments and Exams

Homework will be posted weekly online, that will be graded. The assignments typically consist of two types of problems: Practice exercises designed to help students master the techniques and concepts taught in class; Implementation exercises that should develop numerical, simulation and statistical techniques. For the latter, acceptable programming languages are Python, Matlab and R.

In addition, we will have a midterm examination in week 8, and the final examination in week 15 (see the course schedule for the exact dates).

These should primarily assess:

- Depth of understanding of the concepts, models, and methods.
- Ability to clearly and correctly present mathematical arguments.
- Advanced computational skills.
- Ability to choose an appropriate strategy to solve a problem efficiently.

Grading of Assignments and Exams

The grade for this course will be determined according to the following formula:

Assignments/Activities	% of Final Grade
Online participation (as recorded on NYU Brightspace under *content progress)*	10%
Average weekly homework grade (the lowest grade is dropped)	30%
Midterm examination	30%
Final examination	30%

Letter Grades

Course letter grades will be assigned as follows:

Letter Grade	Points	Percent
A	4.00	95% and higher
A-	3.67	90.0 – 94.99%
B+	3.33	87% - 89.99%
B	3.00	83% - 86.99%
B-	2.67	80% - 82.49%
C+	2.33	77% - 79.99%
C	2.00	70.0% - 76.99%
F	.00	69.99% and lower

View Grades

Brightspace

Course Schedule

Section I2 (Thu. 11:00am–01:30pm): Topics and Assignments

Week/Date	Topic	Reading	Ass. Due
Week 1: 01/22	Sequences of random variables, random sums, example of the symmetric random walk, example: An insurance aggregate loss model.	[AT] Ch. 1	None
Week 2: 01/29	Convergence concepts for random variables, law of large numbers, central limit theorem, Markov sequences, martingale property for sequences of random variables	[AT] Ch. 2	1st
Week 3: 02/05	Discrete Markov chains and applications: basic concepts, long-run distribution, the gambler's ruin problem, examples of applications to Insurance, credit risk, credit ratings	[AT] Ch. 3	2nd
Week 4: 02/12	A Markov Chain in continuous time: the Poisson process	[AT] Ch. 4	3rd
Week 5: 02/19	The Binomial tree model for option pricing: definition of an arbitrage opportunity, no arbitrage pricing theory, the risk-neutral probability measure, hedging portfolio, risk-neutral pricing formula, examples of the European and the lookback options.	[AT] Ch. 5	4th
Week 6: 02/26	Introduction to stochastic processes	[AT] Ch. 6 [RC]	5th
Week 7: 03/05	The continuous-time limit of the random walk	[AT] Ch. 7	6th
Week 8: 03/12	Midterm exam (in class)		
03/16–03/20	Spring break		
Week 9: 03/26	The Brownian Motion, definition and properties, quadratic variation, First hitting Time, maximum up to date, the gambler's ruin model in continuous time.	[AT] Ch. 8	None
Week 10: 04/02	Stochastic integration and mean squares convergence stochastic differentiation, Ito Processes and Ito's formula, application to the Geometric Brownian Motion model for asset prices, and the Vasicek interest rate	[AT] Ch. 9	7th
Week 11: 04/09	Black-Scholes lognormal model via formal integration Monte Carlo simulation and option value	[AT] Ch. 10	8th

Week 12: 04/16	The Black-Scholes Partial Differential Equation Finite Difference approximation method	[AT] Ch. 11	9th
Week 13: 04/23	One period investment models	[AT] Ch. 12	10th
Week 14: 04/30	Complements in option pricing	[AT] Ch. 13	11th
Week 15: 05/07	Final exam (in class)		

Course Materials

Texts & Materials

- [AT] Course notes by Agnès Tourin (main reference).
- [RM] Empirical properties of asset returns: stylized facts and statistical issues, Rama Cont, Quantitative Finance, 1 (2001) 223–236, https://doi.org/10.1080/713665670
- Additional readings may be assigned during class.

Resources

- Access your course materials: NYU Brightspace
- Databases, journal articles, and more: Bern Dibner Library (library.nyu.edu)
  NYU Virtual Business Library (guides.nyu.edu/vbl)
- Obtain 24/7 technology assistance: Tandon IT Help Desk (soehelpdesk@nyu.edu, 646.997.3123)
  NYU IT Service Desk (AskIT@nyu.edu, 212-998-3333)

Policies

Academic Misconduct

A. Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School's rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct.

B. Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:
    1. Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
    2. Fabrication: including but not limited to, falsifying experimental data and/or citations.
    3. Plagiarism: Intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
    4. Unauthorized collaboration: working together on work that was meant to be done individually.
    5. Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission have been received from the course instructor(s) or research adviser involved.
    6. Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.

Disability Disclosure Statement

Academic accommodations are available for students with disabilities. Please contact the **Moses Center for Students with Disabilities** (212-998-4980 or mosescsd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the Moses Center as early as possible in the semester for assistance.

Inclusion Statement

The NYU Tandon School values an inclusive and equitable environment for all our students. I hope to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. It is my intent that all students' learning needs be addressed both in and out of class and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. If this standard is not being upheld, please feel free to speak with me.

Using Generative AI

This policy was adapted from the NYU page https://www.nyu.edu/faculty/teaching-and-learning-resources/Student-Learning-with-Generative-AI.html

- You **are encouraged** to use Generative AI as a learning-aid for the course material.
- You **may** use AI tools **responsibly** for the completion of the homework assignments.
    - 'Responsibly' means in particular that you should always **independently verify and check** the output produced by AI.
    - If you use AI, you **must** transparently document your use of it.
    - You **may not** simply copy and paste the output generated by an AI. Also just rephrasing an AI-generated output is **not enough** for it to be considered your own work!
- You **should not** let your use of AI trick you into believing you understood something which in fact you didn't: Keep in mind that 'doing' is very different from 'understanding'. You must still apply and develop your critical and creative thinking while using AI. It is (and remains) your responsibility to master the course material, build the understanding and develop the rigorous mathematical skills set by the course goals **without having to rely on AI**!
- You **will not** be able to use AI for the examinations.