NYU TANDON SCHOOL OF ENGINEERING

FRE-GY 6083
Quantitative Methods in Finance

Instructor Information

- Agnes Tourin, Industry Associate Professor
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- Wednesdays: 2:00pm-4:00pm or by appointment
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Course Information

- FRE-GY 6083, sections A and B
- Quantitative Methods in 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: Students are expected to have knowledge in univariate and multivariate calculus, linear algebra, basic probability and statistics.
- Section A: Monday 2:00pm-4:30pm, in person
- Section B: Wednesday 11:00am-1:30pm, in person
- Section A: Rogers Hall, RH 214
- Section B: 2 MTC, 803

Course Overview and Goals

The main goal of this course is to provide students with a rigorous introduction to quantitative models in Finance. It also constitutes a foundation that more advanced and specialized courses will build on, in the areas of stochastic calculus and option pricing, hidden Markov chain models, computational finance, credit risk, portfolio management and trading strategies.

Upon Completion of this Course, students will be able to:

- implement any basic quantitative model, and understand its assumptions and applications
- Understand the basic underlying concepts that are used in modeling, such as invariance, independence, stationarity, the markov property, the martingale property, and asset price return and volatility.
- Implement simple Monte Carlo simulations and a basic Finite Difference scheme
- Apply their skills in probability to the computation of quantities of interest in Finance, such as an expected profit and loss, its variance, or an option price.

Course Requirements

Class Participation

This course will be delivered in person. The instructor and students will meet at the designated class times. Students will be expected to attend classes, and come prepared to ask questions.

Assignments

There will be graded weekly homework assignments that will consist of practice exercises designed to help the students assimilate the techniques and concepts taught in class and prepare them for the examinations.

Tests & Quizzes

There will be a midterm and a final examination on week 7 and week 15 respectively: students will be required to solve five or six problems, by using the concepts and techniques taught throughout this course.

Assigned Readings

The main reference for this course is a set of typed notes that is made available online. In addition, most lessons have been pre-recorded and the videos will be posted online.

Grading of Assignments

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

Assignments/Activities	% of Final Grade

NYU TANDON SCHOOL OF ENGINEERING

Viewing the online Content (as recorded on NYU Brightspace under *content progress)*	10%
Average weekly homework assignment grade (the lowest grade will be dropped)	30%
Midterm exam	30%
Final Exam	30%

Letter Grades' percentage range

Letter grades for the entire course 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

NYU TANDON SCHOOL OF ENGINEERING

View Grades

- Grades will be posted under grades on the Brightspace site for this course as soon as they are available.

Syllabus

Course Schedule

Topics and Assignments

Week/Date	Topic	Reading	Assignment Due
Week 1 Section B: 09/07 Section A: 09/12	Sequences of random variables, random sums, the symmetric random walk, and an insurance aggregate loss model.	Chapter 1 in course notes	
Week 2 Section B: 09/14 Section A: 09/19	Convergence concepts for random variables, law of large numbers, central limit theorem, Markov sequences, martingale property for sequences of random variables	Chapter 2	First homework assignment is due On 09/19
Week 3 Section B: 09/21 Section A: 09/26	Discrete Markov chains and applications: basic concepts, long-run	Chapter 3	Second homework assignment is due on 09/26

	distribution, the gambler's ruin problem, examples of applications to Insurance, credit risk, credit ratings		
Week 4 Section B: 09/28 Section A: 10/03	A Markov Chain in continuous time: the Poisson process	Chapter 4	Third homework assignment is due on 10/03
Week 5 Section B: 10/05 Section A: 10/11 (legislative day)	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.	Chapter 5	Fourth homework assignment is due on 10/12
Week 6 Section B: 10/12 Section A: 10/17	Introduction to stochastic processes: preliminary concepts and examples	Chapter 6	Fifth homework assignment is due on 10/17
Week 7 Section B: 10/19 Section A: 10/24	Midterm examination	Review notes, videos, homework, exercises solved in class	The paper is due at the end of the class

NYU TANDON SCHOOL OF ENGINEERING

Week 8 Section B: 10/26 Section A: 10/31	The continuous-time limit of the random walk	Chapter 7	
Week 9 Section B: 11/02 Section A: 11/07	Brownian Motion, definition and properties, quadratic variation, First hitting Time, maximum up to date, the gambler's ruin model in continuous time.	Chapter 8	Sixth homework assignment is due on 11/07
Week 10 Section B: 11/09 Section A: 11/14	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 model.	Chapter 9	Seventh homework assignment is due on 11/14
Week 11 Section B: 11/16 Section A: 11/21	Black-Scholes lognormal model via formal integration Monte Carlo simulation and option value	Chapter 10	Eighth homework Assignment is due on 11/21

NYU TANDON SCHOOL OF ENGINEERING

Week 12 Section B: 11/30 Section A: 11/28	The Black-Scholes Partial Differential Equation Finite Difference approximation method	Chapter 11	Ninth homework Assignment is due on 11/30
Week 13 Section B: 12/07 Section A: 12/05	One period investment models	Chapter 12	Tenth homework assignment is due on 12/07
Week 14 Section B: 12/14 Section A: 12/12	Complements in option pricing and review	Chapter 13	Eleventh homework assignment is due on 12/14
Week 15 Section B: 12/21 Section A: 12/19	Final Examination In the classroom	Review the notes, videos,examples seen in class, and homework	Paper is due at the end of the class.

Tests and Quizzes

- Midterm examination on week 7:
  - Section A: 10/24, at the regular class time and location
  - Section B: 10/19, at the regular class time and location
- Final examination on week 15:
  - Section A: 12/19, at the regular class time and location
  - Section B: 12/21, at the regular class time and location

NYU TANDON SCHOOL OF ENGINEERING

Course Materials

Required Textbooks & Materials

- None required

Resources

- **Access your course materials**: nyu-lms-brightspace.html
- **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 has 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.