FRE6233
Option Pricing and Stochastic Calculus

Instructor Information

- *Roza Galeeva, Adjunct Professor*
- *Office hours: by appointment*
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Course Information

- FRE6233
- Option Pricing and Stochastic Calculus
- The course provides the mathematical foundation of Option Pricing models
- FRE 6083
- Tuesdays, 6-8.30 pm
- [Class room number and building] TBA
- [Virtual (online) meeting days and times, if any] TBA

Course Overview and Goals

The course provides the mathematical foundation of Option Pricing models. The techniques covered include arithmetic and geometric Brownian motion, first passage time, the reflection principle, the stochastic Ito Integral, Ito differential Calculus, change of probability measure, martingales, SDE and PDE. Some of the pricing models considered are the European, Barrier, Asian and American Options. These problems are solved either analytically or numerically, by applying approximations and simulation methods.

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

- The students will be able to price any derivative security.
- Have a foundation for more advanced courses such as "Continuous time Finance"
- The students will prepare to apply for quantitative positions, as well a Ph.D. program in Financial Engineering or Mathematical Finance.
- Learn the important material which is a part of the common knowledge shared by quants in the Financial Industry

Course Requirements

Class Participation

The students are expected to attend the classes and participate actively. You should be using laptops/computers, we will be doing often work in the class. If for any reason you can't come to lecture, please inform me by email in advance.

Assignments

Weekly home assignments, due on weeks 2, 3, 4, 5, 8, 10, 11, 12 ,13, 14 count for 30% of the final grade. Home assignments are due by 5pm, before our class time and have to be uploaded on the NYU classes site. No extensions on home assignments. You need to submit your own version and fully understand the solution. No plagiarism, no copying.

Tests & Quizzes

There will a midterm exam, final exam, home assignments and short quizzes. The exam will be held in the classroom, on the scheduled class time, week 8. Final exam will be week 15, at the usual scheduled class time. In lieu of midterm or final there might be a team project assignment.

Required Readings

The lecture notes will be posted each week prior to the class.

1. S. Shreve, *Stochastic calculus for Finance II: continuous-time series*, 2 edition, 2004, Springer (can be found online for free)

There are some books, which I would recommend (but they are not obligatory)

- P. Glasserman, *Monte Carlo Methods in Financial Engineering*, 2004, Springer
- B. Oksendal, *Stochastic Differential Equations: An introduction with Applications*. Springer 2009.
- R. Cont and P. Tankov, *Financial Modeling with Jump Processes*, 2004, Chapman & Hall.
- I will provide additional references to research papers during the course.

Recommended software for classwork and homework:

Students will be required to use a programming language for prototyping, such as Matlab, R (http://www.r-project.org), or Python.

Grading of Assignments

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

Assignments/Activities	% of Final Grade
Midterm	[30%]
Final exam	[35%]
Home assignments	[30%]
Participation and quizzes	[5%]

Letter Grades

Letter grades for the entire course will be assigned as follows:

Letter Grade	Points	Percent
A	4.00	Example: 92.5% and higher
A-	3.67	Example: 90.0 – 92.49%
B+	3.33	Example: 87.5% - 89.99%
B	3.00	Example: 82.5% - 87.49%
B-	2.67	Example: 80% - 82.49%
C+	2.33	Example: 77.5% - 79.99%
C	2.00	Example: 70.0% - 77.49%
F	.00	Example: 69.99% and lower

View Grades

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Course Schedule

Topics and Assignments

Week/Date	Topic	Reading	Assignment Due
Week 1 Sep 7 20212	Infinite Probability Spaces; Sigma Fields and Conditional Expectations	Shreve textbook, chapters 1-2	
Week 2 Sep 14 2021	The Brownian motion, quadratic variation, Ito lemma	Shreve textbook Chapter 3	1 assignment is due by 5pm
Week 3, Sep 21 2021	Ito integral	Shreve textbook Chapter 4	2 assignment is due by 5pm
Week 4, Sep 28 2021	Application of Stochastic Calculus to the Black Scholes Model	Shreve textbook Chapter 4	3 assignment is due by 5 pm
Week 5, Oct 5 2021	Girsanov theorem	Shreve textbook, chapter 5	4 assignment is due by 5 pm
Week 6, Oct 12 2021	Legislative day		5 assignment is due by 5 pm
Week 7 Oct 19 2021	PDE approach	Shreve textbook, chapter 6	6 assignment is due by 5 pm
Week 8, Oct 26 2021	Midterm		
Week 9, Nov 2 2021	American Option	Shreve textbook, chapter 8	
Week 10, Nov 16 2021	Stochastic calculus in several dimensions, multi-dimensional asset pricing models , introduction to the change of Numeraire, applications to FX	Shreve textbook, chapter 9	7 assignment is due by 5 pm

	and commodity derivatives		
Week 11 , Nov 23 2021	Barrier Options	Shreve textbook, chapter 7	8 assignment is due by 5 pm
Week 12 , Nov 30 2021	Asian Options	Shreve textbook, chapter 7	9 assignment is due by 5pm
Week 13, Dec 7 2021	Review	Lecture notes	10 assignment is due by 5pm
Week 14, Dec 14 2021	Final exam		

Course Materials

Required Textbooks & Materials

1. S. Shreve, *Stochastic calculus for Finance II: continuous-time series*, 2 edition, 2004, Springer (can be found online for free)

Resources

- **Access your course materials**: NYU Classes (nyu.edu/its/classes)
- **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.