QFGB8915: Introduction to Stochastic Calculus

Syllabus, Fall 2022

Yuewu Xu, Ph.D.
School of Business, Fordham University
E-mail: Yuxu@Fordham.Edu (preferred), Phone: (212) 636-6126 (LC)

Class Meetings

Section 001: Tuesday and Thursday 3:30PM – 5:30PM (New York local time) via Zoom
[See Blackboard for class Zoom link information]

Office Hours

The office hours TBA. *Prior email notice requested.*

Course Materials

Official Textbook:

Shreve, S.E. (2004) *Stochastic Calculus for Finance II: Continuous-Time Models*, Springer
Lecture notes and supplemental materials will be distributed in class (also on the Blackboard website).

Reference Books:

Oksendal, B. Stochastic Differential Equations (5th Edition), Springer (for math majors)

Hirsa, A. and Netfci, S. (2013) *An Introduction to the Mathematics of Financial Derivatives* (3rd Edition), Academic Press

Ingersoll, Jonathan (1987) *Theory of Financial Decision Making*, Rowman & Littlefield.

Some Useful Information (optional)

Computing Software and Device:

MATLAB (student version) software is needed for the certain topics of the course.

Professional Market Information System:

The Bloomberg Terminals (quotes are 15-20 minutes delayed) are available at GBA. Every Fordham students can create a Bloomberg account and use it to get market information the same way as Wall Street professionals.

Recommend Readings:

Three recommended readings on the history and development of option pricing theories:

[1] *Fischer Black and the Revolutionary Idea of Finance*, by Perry Mehrling, Wiley (June 24, 2005).

[2] *When Genius Failed: The Rise and Fall of Long-Term Capital Management*, by Roger Lowenstein, Random House, 2000.

[3] *Inventing Money: The Story of Long-Term Capital Management and the Legends Behind It*, by Nicholas Dunbar, John Wiley & Sons, 2000.

The reading of *Wall Street Journal* and *Financial Times* on a regular basis is also recommended.

Course Objectives

This course introduces the students the key concepts and techniques in stochastic calculus which have become the basic tools for modern finance, especially derivatives pricing. The course starts from the definition of stochastic integration, and progresses to Ito's formula, the concept of stochastic differential equation, and then move to the more advanced topics such as the link between PDE and SDE (Feynman-Kac formula), etc. Key applications in finance such as deriving the celebrated Black-Scholes option pricing formula, etc. will be discussed. After the course, the students should have acquired a solid knowledge and skills in stochastic calculus to handle real world problems in the financial industry.

Honor Code

Students must comply with University Policies for conduct and academic honesty at all times during this course. These policies can be obtained from the Administrations of University. Any violations of these policies will result in referral to the appropriate administrative body.

Course Guidelines/Suggestions

(1) **Attendance:** You are *required* to attend the classes. Good class attendance and participation will be helpful in borderline cases. *If you miss 3 lectures, your grade will be lowered to the next notch.*

(2) **Readings:** You are expected to complete the required readings before each class.

(3) **Homeworks:** There will be several homework assignments. They must be done independently and handed timely. *No late assignments will be credited.*

NOTE: Homework should be typed (use LaTex or Microsoft Equations). No handwritten homework will be graded.

(4) **Exams:** one Midterm Exam and one Final Exam. The final exam covers the entire course. All exams are closed-book. However, you are allowed to bring in one *hand-written* sheet (A4) of summary notes (one side only!).

Important Note: In the event that you are unable to take the exams on the scheduled date, you should notify me at least one week in advance. The makeup exam in such a case can only be scheduled before and NOT after the official date. To be fair to all students, no makeup final and midterm exams after the official date!

(5) **Grading Formula:** The grade for the entire course is determined by the following formula:

```
HW(30%)+Midterm(30%)+FinalExam(40%)
```

REGRADING POLICY: The re-grading period for all the exams extends up to one week after the graded exams are made available. If regrading is requested, each and every question will be regraded. There is no selective regrading and no guarantee that the grade will not be lowered. When requesting regarding, you should submit a written (no hand written please) explanation of your questions about the exam to me.

Feedbacks

You are most welcome to give me feedback about the course material, my teaching style and anything else that would help you learn the course material better. Please feel free to talk to me if you have any suggestions and/or concerns.

Course Topics (Tentative, See Spreadsheet for Teaching Schedule)

[1] Some basic concept of Stochastic process: conditional probability, conditional expectation, martingale, etc.

[2] Brownian motion, Quadratic variation, etc.

[3] Ito's integral

[4] Ito's formula (change of variable)

[5] Stochastic differential equations, Markov property

[6] Applications of Ito's formula: Black-Scholes option pricing theory

[7] Risk-neutral measure, Girsanov's theorem (change of measure)

[8] Martingale representation theorem, existence and uniqueness of risk-neutral measure

[9] Feynman-Kac theorem, links to partial differential equations

[10] Other applications of stochastic calculus to finance

[11]Poisson process, compound Poisson process, jump processes (time permits)