New York University Tandon School of Engineering

Department of Finance and Risk Engineering
Course Outline FRE 6083
Quantitative Methods In Finance
Fall 2018
Mirela M Ivan

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Lecture periods: 2.5 hours
Laboratory periods: 0 hours
Recitation periods: 0 hours

Course prerequisites:

Students are expected to have knowledge in calculus, linear algebra, basic probability and statistics. Those students who do not have this background should take the Probability and Statistics refresher courses.

Course Description:

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 Objectives

The main goal of this course is to provide the students with a rigorous introduction to quantitative models in Finance. First of all, the students will be taught the basic concepts of stochastic processes that constitute a prerequisite to quantitative modeling and Econometrics. Secondly, they will become familiar a number of specific models and their underlying assumptions. Finally, this course also serves as an introductory course to the area of Computational Finance and prepares the students to pursue coursework in the Computational Finance track.

Course Structure

This course will be delivered through a series of lectures, followed by a question and answer session and a discussion.

Readings

A set of notes and a list of recommended books and articles will be distributed weekly through NYU classes. In addition, there are two mandatory textbooks for this course:

1. Sheldon Ross, *Introduction to Probability Models,* 11edition, Academic Press, 2014.

2. Ali Hirsa and Salih N. Neftci, *An Introduction to the Mathematics of Financial Derivatives*, 3rd edition, Academic Press, 2014.

Course requirements

Students will be expected to read materials ahead of course meetings to participate actively in class and also be prepared to discuss assignments in class. They are also required to hand weekly Homework assignments in.

<u>Grading</u>:

10%	Homework (weekly assignments)
40%	Midterm Examination, October 24th, 2018
50%	Final Examination, December 19th 2018

Syllabus

Week	Topics
1	Sequences of random variables, random sums, example of the symmetric random walk, application to an insurance aggregate loss model
2	Convergence concepts for random variables, law of large numbers, central limit theorem Markov sequences, martingale property for sequences of random variables
3	Discrete Markov chains and applications: basic concepts ,long-run distribution, the gambler's ruin problem, examples of applications to Insurance, credit risk, credit ratings
4	Stochastic Processes, part I: introduction, basic definitions, Bernouilli process, random walk, stationarity, independence.
5	Stochastic processes, part II: ergodicity, Poisson process, features of financial data, issues in Statistical estimations.
6	Arithmetic random walk with and without drift, geometric random walk with and without drift Passing to the continuous-time limit: from the arithmetic random walk to the Brownian motion and from the geometric random walk to the geometric Brownian motion
7	Midterm examination
8	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.
9	Brownian Motion, definition and properties, quadratic variation, First hitting Time, maximum up to date, the gambler's ruin model in continuous time.
10	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 to theVasicek interest rate model.
11	Black-Scholes lognormal model via formal integration Monte Carlo simulation and option value
12	Black Scholes Partial Differential Equation Finite Difference approximation method
13	The one-period portfolio optimization Merton model and connection with the risk-neutral probability measure.
14	Review
15	Final Examination

If you are student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities at 212-998-4980 or mosescsd@nyu.edu.You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 2nd floor.