NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 604: Mathematical Finance
Spring 2019 Graduate Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: This course will explore the structure, analysis, and use of financial derivative instruments deployed in investment strategies and portfolio risk management. Topics include continuous time dynamics, arbitrage pricing, martingale methods, and valuation of European, American, and path dependent derivatives. Effective From: Fall 2011.

Number of Credits: 3

Prerequisites: Fin 641 Derivatives, Math 605 Stochastic Calculus, or permission of the instructor.

Course-Section and Instructors

Course-Section	Instructor
Math 604-102	Professor A. Pole
Math 604-852	Professor A. Pole

Office Hours for All Math Instructors: Spring 2019 Office Hours and Emails

Required Textbooks:

Title	*Arbitrage Theory in Continuous Time*
Author	Bjork
Edition	3rd
Publisher	Oxford University Press
ISBN #	978-0199574742

University-wide Withdrawal Date:The last day to withdraw with a **W** is **Monday, April 8, 2019**. It will be strictly enforced.

COURSE ASSESSMENT CRITERIA

Course Objectives: This course explores the mathematical structure and analysis of models for financial markets, where the primary goal is valuation of financial derivative instruments deployed in investment strategies and portfolio risk management. Topics include discrete and continuous time dynamics, static and dynamic hedging, portfolio replication of claims, arbitrage pricing, martingale methods, and valuation of European, American, and path dependent derivatives.

Course Outcomes

After completing this course students will be able to:

- Describe the mathematical structure of regularly traded financial derivative securities, including European, American and exotic options.
- Describe and demonstrate risk neutral (arbitrage) pricing of derivative securities.
- Describe and demonstrate the analysis of the standard discrete and continuous time derivative security pricing models.

Course Assessment: Assessment of objectives is achieved through homework assignments, a project [TBD], and two examinations: a midterm exam and a comprehensive final exam.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework Assignments	30%
Project	10%
Midterm Exam	30%
Final Exam	30%

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

Exams: There will be one midterm exam held in class during the semester and one comprehensive final exam. Exams are held on the following days:

Midterm Exam	Week 7
Final Exam Period	May 10 - 16, 2019

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: To properly report your absence from a midterm or final exam, please review and follow the required steps under the DMS Examination Policy found here:

- http://math.njit.edu/students/policies_exam.php

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Accommodation of Disabilities: Disability Support Services (DSS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Fenster Hall, Room 260. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Disability Support Services (DSS) website at:

- http://www5.njit.edu/studentsuccess/disability-support-services/

Important Dates (See: Spring 2019 Academic Calendar, Registrar)

Date	Day	Event
January 22, 2019	T	First Day of Classes
February 1, 2019	F	Last Day to Add/Drop Classes
March 17 - 24, 2019	Su - Su	Spring Recess - No Classes, NJIT Open
April 8, 2019	M	Last Day to Withdraw
April 19, 2019	F	Good Friday - No Classes, NJIT Closed
May 7, 2019	T	Friday Classes Meet/ Last Day of Classes
May 8 & 9, 2019	W & R	Reading Days
May 10 - 16, 2019	F - R	Final Exam Period

Course Outline

Week 1
INTRODUCTION & OVERVIEW: Derivative Securities; primary assets; Law of one price; no free lunch; Overview of derivatives pricing: arbitrage pricing, static & dynamic replication; Self-financing portfolio; Black Scholes Merton; risk-neutral/martingale pricing; *[Björk Chapter 1 and other material]*
Week 2
Binomial model, one period and multi-period; arbitrage condition; replicating portfolios; risk neutral valuation; contingent claims; complete market; martingale measure *[Björk Chapter 2]*
Week 3
Further developments in the Binomial Market Model: hedge portfolios; Real world vs risk neutral probability; CRR and JR parameterization; Demonstration of European and American put valuation on trees; simulation; [Utility maximization for 1-period model] *[Björk, Kennedy Chapter 2]*

Week 4
Even more developments in the Binomial Market Model: Early exercise (American) and barrier options – Valuation proofs; Change of probability; discussion of generalization & Radon-Nikodým; Path dependent claims; Examples of martingale measure calculation *[Professor supplied material]*
Week 5
N-Asset – M-state 1 period model; Arrow-Debreu state prices; Summary of discrete model analysis *[Björk Chapter 3 & other material]*
Week 6
Stochastic calculus summary review and illustration; Stochastic Differential Equations *[Björk Chapter 4, 5]*
Week 7
MIDTERM EXAM
Week 8
Portfolio Dynamics: the continuous time analogue of concepts in classes 1-5 including arbitrage pricing & development of Black-Scholes PDE *[Björk Chapter 6, 7]*
Week 9
More Black-Scholes analysis: Options on futures; American options; Completeness & Hedging; Parity Relations & Delta Hedging; *[Björk Chapter 7,8,9]*
Week 10, 11
Martingale Approach to Arbitrage; Constructing risk neutral measure from call prices *[Björk Chapter 10, 11, 12 (parts)]*
Week 12, 13
Exotic Derivatives *[Musiela & Rutkowski Chapter 6, Epps Chapter 7]*
Week 14
Incomplete Markets; Dividends; Stochastic Volatility

[Björk Chapter 15, 16]
Week 15
FINAL EXAM