NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 606: Term Structure Models
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 606-102	Professor Professor A. Pole

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

Required Textbooks:

Title	*Fixed Income Securities*
Author	Veronesi
Publisher	John Wiley & Sons, Inc.
ISBN #	978-0470109106

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 develops the mathematical structure of interest rate models and explores the considerable hurdles involved in practical implementation. Short rate models, single and multifactor; the Heath-Jarrow-Morton framework; and Libor market models are examined.

Course Outcomes

After completing this course students will be able to:

- Construct yield curves from market data; describe the multifactor structure of rates
- Describe the structure of commonly used models for interest rates
- Calibrate models to market data
- Use calibrated models to price complex interest rate derivative securities
- Assess security and portfolio sensitivities to market interest rate changes

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. AttendanceNote

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 8
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
Overview of interest rates and fixed income instruments & markets
Week 2
Yield curve construction & modeling: Bootstrap; Nelson-Siegel & Svensson curves
Week 3 & 4
Principal Components Analysis; Factor modeling & case study *[Veronesi Chapter 3, 4]*
Week 5
Binomial tree models for interest rates; coupon bond pricing on trees; Market price of interest rate risk; risk neutral pricing and dynamic replication *[Veronesi Chapter 9, 10]*
Week 6
Risk neutral trees and derivative pricing; discrete Ho-Lee & Black-Derman-Toy; Pricing caps, floors, swaps & swaptions *[Veronesi Chapter 11]*
Week 7

Pricing American options on binomial interest rate trees; dynamic replication of callable bonds; option replication; non-convexity; option adjusted spread *[Veronesi Chapter 12]* Briefly, as time permits: Monte Carlo simulation on interest rate trees; pricing path dependent options & application to index amortizing swaps; pricing mortgage backed securities *[Veronesi Chapter 13]*
Week 8
MIDTERM EXAM
Week 9
Martingale valuation & change of numeraire with interest rates *[Pelsser Chapter 1, 2; Björk Chapter 22]*
Week 10 & 11
Short rate models; affine class; Ho-Lee; Vasicek; Cox-Ingersoll-Ross; Hull-White; Dothan; BDT; Black-Karasinski Forward measure; *[Björk Chapter 23, 24; Veronesi Chapter 15, 19, 20]*
Week 12, 13, & 14
HJM methodology; Black model; cap & caplet pricing; LIBOR market models; volatility structures Jamshidian decomposition; two factor models; *[Veronesi Chapter 21, 22]*
Week 15
FINAL EXAM