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 develop the mathematical structure of interest rate models and explore the considerable hurdles involved in practical implementation. Short rate models, single and multifactor; the Heath-Jarrow-Morton framework; and modern Libor market models will be examined. Effective From: Fall 2011.

Number of Credits: 3

Prerequisites: Math 605, or permission of the instructor. Corequisite: Math 608.

Course-Section and Instructors

<table>
<thead>
<tr>
<th>Course-Section</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 606-102</td>
<td>Professor A. Pole</td>
</tr>
</tbody>
</table>

Required Textbooks:

<table>
<thead>
<tr>
<th>Title</th>
<th>Fixed Income Securities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Veronesi</td>
</tr>
<tr>
<td>Edition</td>
<td>---</td>
</tr>
<tr>
<td>Publisher</td>
<td>John Wiley &amp; Sons, Inc.</td>
</tr>
<tr>
<td>ISBN #</td>
<td>978-0470109106</td>
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</table>

University-wide Withdrawal Date: Please note that the last day to withdraw with a W is March 28, 2016. 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 modern Libor market models are examined.
Course Outcomes

After completing this course students will be able to:

- Construct yield curves from market data; understand 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 moves

Course Assessment: Assessment of objectives is achieved through homework assignments and examinations.

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.

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 weeks:

<table>
<thead>
<tr>
<th>Midterm Exam</th>
<th>Week 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Exam Period</td>
<td>May 6 - 12, 2016</td>
</tr>
</tbody>
</table>

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 their absence during a midterm or final exam, please review 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: NJIT is committed to providing students with documented disabilities equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact the Coordinator of Student Disability Services located in the Center for Counseling and Psychological Services, in Campbell Hall, Room 205, (973) 596-3414. Further information on disability services related to the self-identification, documentation and accommodation processes can be found on the webpage at:


Important Dates (See: Spring 2016 Academic Calendar, Registrar)

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 19, 2016</td>
<td>T</td>
<td>First Day of Classes</td>
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</tbody>
</table>
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]

**Week 12, 13, 14**

HJM methodology;
Black model; cap & caplet pricing; LIBOR market models; volatility structures
Jamshidian decomposition; two factor models;

*Time permitting*: Estimation: generalized method of moments; maximum likelihood

**Week 15**

**FINAL EXAM**