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

<table>
<thead>
<tr>
<th>Course-Section</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 604-102</td>
<td>Professor A. Pole</td>
</tr>
</tbody>
</table>

Required Textbook:

<table>
<thead>
<tr>
<th>Title</th>
<th>Arbitrage Theory in Continuous Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Bjork</td>
</tr>
<tr>
<td>Edition</td>
<td>3rd</td>
</tr>
<tr>
<td>Publisher</td>
<td>Oxford University Press</td>
</tr>
<tr>
<td>ISBN #</td>
<td>978-0199574742</td>
</tr>
</tbody>
</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 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 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 7</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:* There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor’s note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

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

**ADDITIONAL RESOURCES**

*Math Tutoring Center:* Located in Cullimore, Room 214 (See: Spring 2016 Hours)

*Further Assistance:* For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department’s webpage for Instructor Office Hours and Emails.

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

*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>
</tr>
<tr>
<td>January 25, 2016</td>
<td>M</td>
<td>Last Day to Add/Drop Classes</td>
</tr>
<tr>
<td>March 13 - 20, 2016</td>
<td>Su - Su</td>
<td>Spring Recess - No Classes, University Open</td>
</tr>
<tr>
<td>March 25, 2016</td>
<td>F</td>
<td>Good Friday - No Classes, University Closed</td>
</tr>
<tr>
<td>May 3, 2016</td>
<td>T</td>
<td>Friday Classes Meet/ Last Day of Classes</td>
</tr>
<tr>
<td>May 4 &amp; 5, 2016</td>
<td>W &amp; R</td>
<td>Reading Days</td>
</tr>
<tr>
<td>May 6 - 12, 2016</td>
<td>F - R</td>
<td>Final Exam Period</td>
</tr>
</tbody>
</table>

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**
Early exercise (American) and barrier options: Valuation proofs in binomial market model; Change of probability in binomial model; discussion of generalization & Radon-Nikodym; Path dependent claims in binomial model; 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]
<table>
<thead>
<tr>
<th>Week 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete Markets; Dividends; Stochastic Volatility</td>
</tr>
<tr>
<td>Björk Chapter 15, 16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINAL EXAM</td>
</tr>
</tbody>
</table>

Updated by Professor A. Pole - 1/15/2016  
Department of Mathematical Sciences Course Syllabus, Spring 2016