



北京大學  
汇丰商学院

Peking University HSBC Business School

# Course Code

## Applied Stochastic Processes

### Module 1, 2015-2016

#### Course Information

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**Instructor: Kwangwon Ahn**

Office: PHBS Building, Room 750

Phone: 86-755-2603-2024

Email: k.ahn@phbs.pku.edu.cn

Office Hour: Monday and Thursday 6:00 – 6:50pm

**Teaching Assistant: Adam Lin, Jacqueline Dai**

Phone: 86-185-6666-8521

Email: adam.lin@sz.pku.edu.cn

**Classes:**

Lectures: Monday and Thursday 8:30 – 10:20pm

Venue: PHBS Building, Room 229

**Course Website:**

<http://www.finstab.net/>

## 1. Course Description

### 1.1 Context

Course overview:

This course is designed to provide students with mathematical background on the stochastic processes and its applications to the modern Finance. The course begins with intermediate probability theory and the derivation of the famous Black-Scholes' formula. Subsequently, three solution methods of the BS formula are introduced, i.e. using CRR model, heat equation, and quantum methods. In addition, three applications are introduced, i.e. 'Market Microstructure', 'Financial Stability', and 'A Quantum Model of the Stock Market'.

Prerequisites:

Advanced Calculus, Probability Theory and Mathematical Statistics

### 1.2 Textbooks and Reading Materials

Textbooks:

Baaquie, B.E., "Quantum Finance: Path Integrals and Hamiltonians for Options and Interest Rates," Cambridge University Press, 2007

Hull, J., "Options, Futures and Other Derivatives," Prentice Hall, 2006

Gut, A., "An Intermediate Course in Probability Theory," Springer, 2009

Liboff, R.L., "Introductory Quantum Mechanics," Addison-Wesley, 1980

Merton, R., "On the Pricing of Corporate Debt: The risk structure of interest rates," J.F., 2012

Nielsen, L.T., "Pricing and Hedging of Derivative Securities," Oxford University Press, 1999  
 Shreve, S., "Stochastic Calculus for Finance II: Continuous-Time Models," Springer, 2007

## 2. Learning Outcomes

### 2.1 Intended Learning Outcomes

Learning Goals	Objectives	Assessment
1. Our graduates will be effective communicators.	1.1. Our students will produce quality business and research-oriented documents.	O
	1.2. Students are able to professionally present their ideas and also logically explain and defend their argument.	O
2. Our graduates will be skilled in team work and leadership.	2.1. Students will be able to lead and participate in group for projects, discussion, and presentation.	
	2.2. Students will be able to apply leadership theories and related skills.	
3. Our graduates will be trained in ethics.	3.1. In a case setting, students will use appropriate techniques to analyse business problems and identify the ethical aspects, provide a solution and defend it.	
	3.2. Our students will practice ethics in the duration of the program.	
4. Our graduates will have a global perspective.	4.1. Students will have an international exposure.	
5. Our graduates will be skilled in problem-solving and critical thinking.	5.1. Our students will have a good understanding of fundamental theories in their fields.	O
	5.2. Our students will be prepared to face problems in various business settings and find solutions.	
	5.3. Our students will demonstrate competency in critical thinking.	O

### 2.2 Assessment/Grading Details

Assessment task	Weighting
Quiz	40%
Assignments	30%
Midterm Exam	20%
Group Project	10%
Total	100%

#### Assignments:

Students are required to submit 7 assignments (hardcopy) to a TA. This is an individual task, not a group work. These assignments will help students to keep track of key ideas of the courses. Late submission does not count towards the final mark.

**Attendance:**

The weight (no absence: 1, one absence: 0.99, two absences: 0.98, and more than two absences: 0.7) will be used for the final GPA adjustment.

**2.3 Academic Honesty and Plagiarism**

It is important for a student’s effort and credit to be recognized through class assessment. Credits earned for a student work due to efforts done by others are clearly unfair. Deliberate dishonesty is considered academic misconducts, which include plagiarism; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; or altering, forging, or misusing a University academic record; or fabricating or falsifying of data, research procedures, or data analysis.

All assessments are subject to academic misconduct check. Misconduct check may include reproducing the assessment, providing a copy to another member of faculty, and/or communicate a copy of this assignment to the PHBS Discipline Committee. A suspected plagiarized document/assignment submitted to a plagiarism checking service may be kept in its database for future reference purpose.

Where violation is suspected, penalties will be implemented. The penalties for academic misconduct may include: deduction of honour points, a mark of zero on the assessment, a fail grade for the whole course, and reference of the matter to the Peking University Registrar.

For more information of plagiarism, please refer to *PHBS Student Handbook*.

**3. Topics, Teaching and Assessment Schedule**

	<b>Date</b>		<b>Topics Covered</b>
1	August 31	<b>Part 1.</b> <b>Probability Theory</b>	Intermediate Probability Theory <b>Gut, A.(Chapters 1, 2 and3)</b>
2	September 2		Random Walk <b>Shreve, S. (Chapter 8)</b>
3	September 7		Measure, Probability and Integration <b>Nielsen, L.T. (Appendices A and B)</b>
4	September 10	<b>Part 2.</b> <b>Stochastic Calculus</b>	Brownian Motion <b>Nielsen, L.T. (Chapter 1), Hull, J. (Chapter 13)</b>
5	September 14		Ito’s Lemma <b>Nielsen, L.T. (Chapter 2), Hull, J. (Chapter 13)</b>
6	September 17		Black-Scholes PDE <b>Nielsen, L.T. (Chapters 5 and 6)</b>
7	September 21		Heat Equation <b>Nielsen, L.T. (Appendix C)</b>

8	September 28		Midterm Exam (20%) <b>Lecture 1 – 7</b>
9	September 24		Price as Martingale Plus Noise <b>Glosten and Milgrom (1985)</b>
10	October 8	Part 3. <b>Market Microstructure</b>	(i) Trading costs <b>Bertsimas and Lo (1998), Hasbrouck (Ch. 15)</b> (ii) Estimating quadratic variation despite the market microstructure <b>Zhou (1998)</b>
11	October 12	Part 4.	Probability of Default (Undercapitalization) <b>Merton (1974), Chan-Lau and Sy (2007)</b>
12	October 15	<b>Financial Stability</b>	Systemic Risk and Financial Fragility <b>Aspachs et al. (2006, 2007), Ahn et al. (2015)</b>
13	October 19		Quiz 1 (20%) & <b>(i) Demo – MATLAB</b>
14	October 22		Operators, Eigenfunctions and Eigenvalues <b>Liboff, R.L. (Chapter 3)</b>
15	October 26	Part 5.	Function Spaces and Hermitian Operators <b>Liboff, R.L. (Chapter 4)</b>
16	October 29	<b>Quantum Finance</b>	Hamiltonians and Stock Options <b>Baaquie, B.E. (Chapter 4)</b>
17	November 2		A Quantum Model for the Stock Market <b>Zhang, C., Huang, L. (2010), Cotfas, L. (2013)</b>
18	November 5		Quiz 2 (20%) & <b>(ii) Demo – MATLAB</b>

#### 4. Miscellaneous

Do not hesitate to come to my office during office hours or by appointment to discuss any aspect of the course.