COURSE OUTLINE: MH4518

Course Title	**Simulation Techniques in Finance**		
Course Code	**MH4518**		
Offered	Study Year 4, Semester 1		
Course Coordinator	PUN Chi Seng (Asst Prof)	cspun@ntu.edu.sg	6513 7468
Pre-requisites	MH2500, MH3511		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12		
Approved for delivery from	AY 2022/23 semester 1		
Last revised	5 May 2022, 10:01		

Course Aims

This course aims to equip you with standard and advanced simulation techniques and cover their applications in finance, including derivatives pricing and risk management. In this course, you will develop skills in modelling and simulating time series data, and based on which you will be able to devise solutions to quantitative finance problems.

Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Implement the basic simulation
2. Incorporate with the variance reduction techniques in simulations
3. Formulate and resolve quantitative finance problems, including derivatives pricing and hedging strategies, with simulation techniques
4. Evaluate a financial product from a risk manager's perspective with simulated forward-looking financial data

Course Content

Generating random numbers and random variables

Generating Brownian motion and other diffusion processes

Variance reduction techniques

Introduction to futures, options, and other derivatives

Pricing exotic options with simulations

Estimating sensitivities of derivatives with simulations

Applications in risk management

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Lectures					
Group Project	1, 2, 3	**1.** a, b, c, d **2.** a, b, c, d **3.** a, b **4.** a **5.** a	35	both	See Appendix for rubric
Assignment	1, 2, 3	**1.** a, b, d **2.** b, c, d **3.** a **4.** a **5.** a	15	individual	See Appendix for rubric
Examination (2 hours)					
Final Examination	1, 2	**1.** a, b **2.** b **3.** a **4.** a	50	individual	See Appendix for rubric
		Total	**100%**		

These are the relevant SPMS-MAS Graduate Attributes.

1. **Competence**
   a. Independently process and interpret mathematical theories and methodologies, and apply them to solve problems
   b. Formulate mathematical statements precisely using rigorous mathematical language
   c. Discover patterns by abstraction from examples
   d. Use computer technology to solve problems, and to communicate mathematical ideas
2. **Creativity**
   a. Critically assess the applicability of mathematical tools in the workplace
   b. Build on the connection between subfields of mathematics to tackle new problems
   c. Develop new applications of existing techniques
   d. Critically analyse data from a multitude of sources
3. **Communication**
   a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience
   b. Work in teams on complicated projects that require applications of mathematics, and communicate the results verbally and in written form
4. **Civic-mindedness**
   a. Develop and communicate mathematical ideas and concepts relevant in everyday life for the benefits of society
5. **Character**
   a. Act in socially responsible and ethical ways in line with the societal expectations of a mathematics professional, particularly in relation to analysis of data, computer security, numerical computations and algorithms

Formative Feedback

Lectures provide systematic instruction of the course content, while tutorials and labs consist of practice questions and lab implementation related to the course content. As a result, you will be provided weekly feedback/knowledge check. Continuous assignments can ensure students and instructor make progress towards achieving the intended learning outcomes (ILOs) #1 and

#2. You will also be required to do a group project on evaluating a financial product (derivative) from a risk manager's perspective (ILO #3), where you need to solve derivative pricing and estimating sensitivities with simulation techniques (ILO #2).

Learning and Teaching Approach

Lectures (39 hours)	Lectures provide systematic instruction of the course content. Besides of lecture slides, the course content is illustrated with the financial products that are currently traded in the market. You will find the immediate use of the knowledge acquired.
Tutorials (12 hours)	Tutorials consist of practice questions related to the course content. These can enhance students' understandings on the course content.

Reading and References

Textbook:
N.H. Chan and H.Y. Wong (2015). Simulation Techniques in Financial Risk Management (2nd Edition), Wiley, New York. Print ISBN:9781118735817 | Online ISBN:9781118735954

Reference books:
N.H. Chan and H.Y. Wong (2013). Handbook of Financial Risk Management: Simulations and Case Studies, Wiley, New York. ISBN: 978-0-470-64715-8

J. S. Dagpunar (2007). Simulation and Monte Carlo: with Applications in Finance and MCMC, Wiley. ISBN: 978-0-470-85494-5

P. Glasserman (2003). Monte Carlo Methods in Financial Engineering, Springer-Verlag, New York. ISBN: 978-0-387-21617-1

Course Policies and Student Responsibilities

(1) General

You are expected to complete all assigned pre-class readings and activities, attend all classes punctually and take all scheduled assignments and tests by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements. You are expected to participate in all discussions and activities.

(2) Absenteeism

Though class attendance is expected, it is not compulsory and being absent from classes does not affect the course grades.

(3) Compulsory Assignments

You are required to submit compulsory assignments on due dates.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the Academic Integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
PUN Chi Seng (Asst Prof)	SPMS-MAS-05-22	6513 7468	cspun@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Introduction and review of some pre-requisites	1	Lecture slides
2	Generating random numbers and random variables	1	Lecture slides
3	Generating random numbers and random variables	1	Lecture slides
4	Generating Brownian motion and other diffusion processes	1	Lecture slides
5	Generating Brownian motion and other diffusion processes	1	Lecture slides
6	Variance reduction techniques	1, 2	Lecture slides
7	Variance reduction techniques	1, 2	Lecture slides
8	Introduction to futures, options, and other derivatives	1, 2, 3	Lecture slides
9	Pricing exotic options with simulations	1, 2, 3	Lecture slides
10	Estimating sensitivities of derivatives with simulations	1, 2, 3, 4	Lecture slides
11	Applications in risk management	1, 2, 3, 4	Lecture slides
12	Applications in risk management	1, 2, 3, 4	Lecture slides
13	Group project presentation	1, 2, 3, 4	Lecture slides

Appendix 1: Assessment Rubrics

Rubric for Lectures: Group Project (35%)

Criteria	Performance Level			
	4	**3**	**2**	**1**
Does this project involve some use of Simulation Techniques in this course?	Involves the novel application of existing simulation techniques and/or discovery of new scientific principles.	The project was designed based on sound simulation techniques.	The project was designed based loosely on simulation techniques and involved mainly uneducated guesses.	No simulation involved in this project.
Are the Mathematics and Techniques used accurate and correct?	Techniques used is accurate and Mathematics is rigorous.	The project contains some minor arguments that may not be correct.	The project contains some dubious arguments.	The project is flawed scientifically or mathematically.
Are the Mathematics and Science of the project presented clearly?	Very clearly explained.	Clearly explained with one or two vague points.	Somewhat unclear and the presentation is not totally coherent.	Badly explained and the presentation is incoherent.
How original are the ideas?	Absolutely original.	Not totally original but has made significant modifications of existing ideas.	Not totally original but has made some modifications of existing ideas.	The project is a direct copy of existing ideas without the slightest modifications or improvements.
Is the project presented creatively, i.e. artistic appeal?	Very creative and captivating.	Creative with some interesting approach.	Quite conventional and traditional.	Nothing creative or appealing.

Other Comments:

Your individual contribution to the project is also taken into account. Hence, members in the same team may have difference scores.

The group project consists of 75% individual score (varies by different members) and 25% group score (same score for all group members). The individual score will be assessed by the individual presentations, contribution statement on each project deliverable, and the individual consultations.

Rubric for Lectures: Assignment (15%)

Point-based marking (not rubrics based).

Rubric for Examination: Final Examination (50%)

Point-based marking (not rubrics based).