Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2022-2023
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Patrick Pun Chi Seng
Course Author Email	cspun@ntu.edu.sg
Course Title	Simulation Techniques in Finance
Course Code	MH4518
Academic Units	4
Contact Hours	51
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH2500, MH3511
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

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.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Implement the basic simulation
ILO 2	Incorporate with the variance reduction techniques in simulations
ILO 3	Formulate and resolve quantitative finance problems, including derivatives pricing and hedging strategies, with simulation techniques
ILO 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

Reading and References (if applicable)

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

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	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 sldies		
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	leture slides		
8	Introduction to futures, options, and other derivatives	1-3	lecture slides		
9	Pricing exotic options with simulations	1-3	lecture slides		

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
10	Estimating sensitivities of derivatives with simulations	1-4	lecture slides		
11	Applications in risk management	1-4	lecture slides		
12	Applications in risk management	1-4	lecture slides		
13	Group project presentation	1-4	lecture slides		

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	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	Tutorials consist of practice questions related to the course content. These can enhance students' understandings on the course content.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Project(Group Project)	1, 2, 3	1. a, b, c, d 2. a, b, c, d 3. a, b 4. a 5. a	35		Individual	Holistic	Extended Abstract
2	Continuous Assessment (CA): Assignment(Assignment)	1, 2, 3	1. a, b, d 2. b, c, d 3. a 4. a 5. a	15		Individual	Analytic	Multistructural
3	Summative Assessment (EXAM): Final exam(Final Examination)	1, 2	1. a, b 2. b 3. a 4. a	50		Individual	Analytic	Relational

Description of Assessment Components (if applicable)

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).

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Collaboration	Intermediate
Decision Making	Advanced
Digital Fluency	Intermediate
Problem Solving	Advanced
Transdisciplinarity	Advanced

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (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.

Policy (Absenteeism)

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

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do

this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Compulsory Assignments:
You are required to submit compulsory assignments on due dates.

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.

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).