The Hong Kong University of Science and Technology

UG Course Syllabus

Course Title: Numerical Methods for Financial Engineering

Course Code: IEDA 4520

No. of Credits: 3 Credits

Pre-requisites:

- (IEDA 3250 OR ISOM 2500) AND (IEDA 3330 OR FINA 3203)
- Basic knowledge in Python or R is recommended

Instructor Name: Prof. Xiaowei Zhang

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Office Hours: By appointment (Room 5541)

Course Description

This course aims to introduce various important numerical methods that have been widely applied in financial engineering, with a focus on Monte Carlo simulation and machine learning.

A tentative list of topics to be covered is as follows.

- Risk-neutral pricing of financial derivatives
- Black-Scholes model
- Monte Carlo methods for option pricing
- Copula models for multivariate financial data
- Stochastic differential equation models for interest rates
- Numerical approximation of stochastic differential equation
- Variance reduction techniques
- Sensitivities estimation
- Nested simulation for risk management

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

ILO1: Understand the theory of the lattice methods used in financial engineering.
ILO2: Understand the principles of the Monte Carlo simulation method and various variance reduction techniques.
ILO3: Know how to apply the Monte Carlo simulation method to derivatives pricing and sensitivity estimation.
ILO4: Know how to finite difference methods are applied in derivatives pricing.
ILO5: Analyze financial engineering problems from the computational perspective.
ILO6: Develop practical skills of solving financial engineering problems through various numerical methods.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments

Assessment Task	Contribution to Overall Course grade (%)	Due date
Homework Assignments (3)	30%	Week 3, 6, 10
Midterm Exam	30%	Week 7
Group Project	40%	Week 13

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Homework Assignments	ILO1, ILO2, ILO3, ILO4	Homework assignments assess students' ability to articulate the use of Monte Carlo simulation in derivatives pricing (ILO2, ILO3) and to comprehend theoretical concepts related to lattice and finite-difference methods covered in the lectures (ILO1, ILO4).
Midterm Exam	ILO1, ILO2, ILO3, ILO4	Midterm exam assesses students' understanding of the core principles and theories of various numerical methods in financial engineering (ILO1, ILO2, ILO3, ILO4). It also assesses their ability to critically analyze, and compare these methods in terms of their advantages and limitations.
Group Project	ILO1, ILO2, ILO3, ILO4, ILO5, ILO6	Group project enables students to put into practice the knowledge learnt in class (ILO1, ILO2, ILO3, ILO4, ILO5) to address real-world financial engineering problems. It assesses students' ability to integrate machine learning techniques with fundamental Monte Carlo simulation methods in a hands-on project (ILO6), enhancing their critical thinking and problem-solving skills.

Grading Rubrics for Group Project

Criteria	Excellent	Good	Satisfactory	Marginal	Fail
Idea (30%)	Ideas are innovative, original, and closely aligned with the course contents, demonstrating significant influence in the field of financial engineering.	Ideas are creative, clear and relevant to the course contents, demonstrating potential influence in the field of financial engineering.	Ideas are adequate and somewhat relevant to the course contents but lack originality or influence in the field of financial engineering.	Ideas lack depth or relevance to the course contents, with limited potential for influence in the field of financial engineering.	Ideas are unclear, entirely irrelevant to the course contents, with no clear purpose or meaningful influence in the field of financial engineering.
Execution (40%)	Execution is perfect supported by excellent teamwork and precise attention to detail.	Well-executed with good teamwork and minor improvement.	Execution is sufficient but may lack cohesion or consistency in teamwork.	Inconsistent execution with significant flaws and poor teamwork.	Poor execution, disorganized, and little to no evidence of teamwork.
Presentation (20%)	Engaging and professional delivery, supported by clear visuals, consistent eye contact, and well-timed execution.	Clear and well-structured delivery, with good use of visuals, eye contact and timing.	Presentation is satisfactory but falls short in clarity, eye contact, effective visuals or timing.	Presentation is unorganized or unclear, with poor visuals, eye contact or timing issues.	Ineffective delivery, unclear, disorganized, and no meaningful visuals or eye contact.
Report (10%)	Comprehensive, well-structured, and thoroughly analyzed with excellent writing.	Detailed and well-organized, with good analysis and clear writing.	Report is adequate but may lack depth, structure, or clarity in writing.	Report is incomplete, poorly structured, or lacks sufficient analysis.	Report misses key components. It is disorganized and poorly written.

Final Grade Descriptors

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Students with excellent performance in the course demonstrate a strong grasp of lecture materials and can effectively apply the tools discussed. They showcase outstanding proficiency in utilizing numerical methods to tackle complicated problems in financial engineering.
B	Good Performance	Students with good performance in the course exhibit a solid understanding of lecture materials and can appropriately apply the tools discussed. They show commendable skill in using numerical methods to aid in problem-solving within financial engineering.
C	Satisfactory Performance	Students with satisfactory performance demonstrate an adequate understanding of lecture materials and can use of tools discussed. They show acceptable competence in using numerical methods to solve problems in financial engineering but may lack depth in analysis and application.
D	Marginal Pass	Students with a marginal pass show limited understanding of lecture materials and inconsistent performance in use of tools. Their ability to use numerical methods to solve problems in financial engineering is limited.
F	Fail	Students who fail the course demonstrate a poor understanding of lecture materials and insufficient use of the tools discussed. They exhibit minimal to no ability to apply numerical methods to solve problems in financial engineering.

Course AI Policy

There are no restrictions on use of generative AI for an assessment task in this course.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include comments on strengths and areas for improvement. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

To ensure fairness for students who submit assignments on time, a penalty for late submission is listed as follows.

- 24-hour grace period, but 20% penalty.
- Late submission for more than 24-hour will not be accepted.

Required Texts and Materials

- Cónall Kelly (2024). *Computation and Simulation for Finance: An Introduction with Python*, Springer.
- Paul Glasserman (2003). *Monte Carlo Methods in Financial Engineering*, Springer.

Logistics

- Lectures: Monday 3:00-4:20pm, Friday 10:30-11:50am @ LSK1027
- Midterm exam: October 13 (7th week)
- Tutorial: Wednesday 6:00–6:50pm @ Room 3207 (Lift 21)
- Project
    - Presentation: November 24, 28
    - Report: December 7

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.