MATH 4514 Financial Economics in Actuarial Science

Course Outline- Spring 2025-2026

1. **Instructor(s)**

   Name: Shuoqing Deng

   Contact Details: masdeng@ust.hk

2. **Teaching Assistant(s)**

   Name: Daxin Huang

   Contact Details: dhuangax@connect.ust.hk

3. **Meeting Time and Venue**

   Lectures:

   Date/Time: Tuesday (13:30-14:50) and Thursday (13:30-14:50)

   Venue: Room 1409

   Tutorials:

   Date/Time: Wednesday (18:00-18:50)

   Venue: Room 1410

4. **Course Description**

   Credit Points: 3

   Pre-requisite: MATH2421 (Probability) and MATH2511 (Fundamental of Actuarial Mathematics).

   Exclusion: NIL

   Brief Information/synopsis:

   The course aims to study some actuarial models and their application in derivative pricing and financial risk management. Topics include introduction to financial derivatives and basic pricing principle, use of options strategies in financial management, development of Binomial tree models in pricing derivative, Black Scholes option pricing model, Options Greeks and the numerical algorithm in pricing derivative under Black-Scholes model.

5. Intended Learning Outcomes

Upon successful completion of this course, students should be able to understand the following topics:

No.	ILOs
1	Various financial derivatives (forward, futures, options, exotic options and interest rate derivatives) and their applications in financial management.
2	General properties of options such as put-call parity, general parity and sensitivity analysis on options price with respect to strike price and time to maturity.
3	Various options strategies (option spreads, collar, straddle, strangle, butterfly spread) and their application in risk management.
4	Binomial tree pricing model and its application in derivative pricing.
5	Black Scholes option pricing model and its model assumptions.

In addition, students would also acquire the following abilities:

6. Appreciate the use of various quantitative methods and numerical methods in derivative pricing.

7. Able to use various financial derivatives to solve problems in financial management under various scenarios.

8. Able to develop suitable pricing models (Black-Scholes model or Binomial tree pricing model) using given market data to price various financial derivatives.

6. Assessment Scheme

a. Examination duration: 3 hrs

b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
15% by assignment	1, 2, 3, 4
30% by midterm	1, 2, 3
55% by final	1, 2, 3, 4, 5

c. The grading is assigned based on students' performance in assessment tasks/activities. Grades will not be assigned using a curve.

d. **Letter Grades:** Students should aim at getting a course total of 85% or above for A-/A/A+, and about 60% or above for B-/B/B+. For getting A- or above, students will need to achieve 85% of the course total, **and** submit a video presentation which demonstrates clear and accurate understanding of the chosen topic. Without a satisfactory submission of the presentation video, your grade will be capped by B+. For students who do not meet the 85%-cutoff, submission of a presentation video will **not** add bonus marks to the course total.

e. **Grade Descriptors:**

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	The student has mastered almost all concepts and techniques of differential geometry taught in the course, has excellent understanding of the deepest content of the subject, and

		acquired workable knowledge for further studies of abstract manifolds, Riemannian geometry, general relativity, and related fields.
B	Good Performance	The student has mastered most computational techniques of differential geometry taught in the course, yet the understanding of some challenging concepts may not be deep enough for further studies on related advanced subjects.
C	Satisfactory Performance	The student meets the minimum expectation of the instructor, has acquired some basic computational techniques of the subject, yet some concepts were not clearly understood.
D	Marginal Pass	The student is only able to recall some fragments of topics and is able to complete some of the easiest computations.
F	Fail	The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations.

7. Student Learning Resources

We will use our own Lecture notes in this course. Additional problem sets (optional) will be provided. All materials can be found in canvas (https://canvas.ust.hk)
The following reference books will be useful:

1. McDonald, Robert, L. (2014). Derivatives Markets, 3rd ed. Pearson (ISBN 10: 1- 292-02125-X). (*Remark: This book covers all contents taught in this course.)
2. Hull, John (2014). Options, Futures, and Other Derivatives, 9th ed. Prentice Hall (ISBN-10: 013345631).

8. Teaching and Learning Activities

Scheduled activities: 4 hrs (lectures + tutorials)

Course AI Policy

Students are allowed to consult any person (including the instructor, TA, classmates, friends outside HKUST) in any homework for ideas and hints, but are required to write up the solutions by themselves. You are required to list the persons and references you have consulted in every homework.

9. Course Schedule

Chapter 1: Introduction to Financial derivatives

- Forward contract, Pre-paid forward contract and Future contract
- Determination of forward price using no arbitrage pricing principle.
- Introduction to options and basic pricing principle

- Properties of options price: Put-call parity on European options, monotonicity and convexity of options price.
- Options strategies and their applications.
- American options and early exercise strategy of American options.

Chapter 2: Binomial tree pricing models

- Single period Binomial tree model: Derivative pricing using no arbitrage pricing principle and risk neutral valuation principle.
- Multi-period Binomial tree model and its applications in pricing American options and path-dependent derivatives (Barrier options, Asian options, Lookback options etc.)
- Construction of binomial tree pricing model using market stock data - Forward binomial tree, Cox-Ross-Rubinstein tree and Lognormal tree
- Binomial tree model on dividend paying stock.

Chapter 3: Black-Scholes option pricing model

- Basic model setup and model assumptions
- Ito's lemma and lognormal distribution for stock price process
- Black-Scholes formula on European call/put options and its derivation.
- Options Greeks, concept of implied volatility.
- Risk neutral valuation principle and its application in derivative pricing.
- Numerical methods - Lattice tree algorithm and Monte-Carlo simulation