MATH4514 Financial Economics in Actuarial Science
Course Outline
Spring Semester 2023-2024

1. **Instructor**

   Name: Dr. Leung Chi Man (Call me LCM if you wish)
   Office: Room 3419 (Lift 17-18)
   E-mail: chimanleung@ust.hk
   Office hours: 2:00p.m.-3:00p.m. every Thursday

2. **Meeting time and Venue**

   Lecture: Mon 4:30p.m.-6:50p.m. @Room1410
   Fri 12:00p.m. - 1:20p.m. @Room1410
   (*The tutorial on Monday will also be used as lecture.)

3. **Course Description**

   Credit point: 3 credits
   Prerequisites: MATH2421 (Probability) and MATH2511 (Fundamental of Actuarial Mathematics).
   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.

4. **Intended Learning Outcome (ILOs)**

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

   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.

5. 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).

6. Teaching and Learning Activities

Lectures (4 hours per week)

7. Tentative 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

8. **Assessment Scheme**

There are 3 assessment tasks in this course:

	Weight	CILOs assessed
Assignment	15% + Bonus	1, 2, 3, 4, 5, 6, 7, 8
Midterm Examination	20%	1, 2, 3, 4, 5, 6, 7, 8
Final examination	65%	1, 2, 3, 4, 5, 6, 7, 8

(a) Assignment (15% of the total grade + Additional Bonus)

There are required problems and optional problems in each of the assignments. You are required to complete all required problems. Also, you may complete some optional problems for bonus score (which may improve your final grade).

(b) Midterm examination (20% of the total grade)

It will be in-class 1.5 hours closed-book exam. The details will be announced later.

(c) Final Examination (65% of the total grade)

It will be a 2.5~3 hours closed-book exam. The exam will cover **all** materials taught in the course. The exam date and venue will be scheduled by ARR. The exam format will be announced in the last class of this course.

(*Note: You can pass the course for sure if you get at least 40% overall in this course and get at least 25 points (out of 100) in the final exam.)
(**Note 2: Your final grade will be determined based on absolute grading scheme)