MATH4512 Fundamentals of Mathematical Finance
Course Outline
Spring Semester 2023-2024

1. **Instructor**

   Name: Dr. Leung Chi Man (Call me LCM if you wish)
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   Office hours: (Thurs) 2:00p.m.- 3:00p.m.

2. **Meeting time and Venue**

   Lecture: Weds 4:30p.m.- 6:50p.m. @Room 2306
   Fri ~~12:00p.m. 1:20p.m.~~ 4:30p.m.- 5:50p.m. @Room 2306
   (* The tutorial on Wednesday is combined with the lecture)
   (** There is no attendance policy. However, all students are expected to attend the classes)

3. **Course Description**

   Credit point: 3 credits
   Prerequisites: Multivariable Calculus (MATH2010, MATH2011, MATH2021 or MATH2023), Linear Algebra (MATH2111, MATH2121, MATH2131 or MATH2350), Basic knowledge in probability and statistics (IELM2510, ISOM2500, LIFS3150 or MATH2411) and basis knowledge in finance (FINA2203 or FINA2303).

   This course is directed to those students who would like to acquire an introduction to the fundamental principles of quantitative finance and financial economics. Topics include bond portfolio management and immunization, Markowitz portfolio theory, capital asset pricing models, arbitrage pricing theory and factor models, investment performance analysis, utility optimization in investment decisions.

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

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

   1. Duration and horizon rate of return, bond portfolio management and immunization, application of bond immunization in asset-liability management
   2. Mean-variance formula of portfolio choices of risky assets. Two-fund theorem and one-fund theorem.
   3. Asset pricing under the capital asset pricing model (CAPM) and factor models. Investment performance analysis.
   4. Utility optimization in investment decisions and stochastic dominance.

In addition, students would also acquire the following abilities:

5. Appreciate the use of various quantitative methods to analyse issues related to portfolio choice problems and investment performance analysis.
6. Recognize the importance of applying rigorous and numerate approach to analyse and solve problem in financial economics.
7. Apply mathematical modelling and analytic proofs, as well as statistical analyses, to describe and explain phenomena in financial economics models.
8. Communicate the solutions of mathematical models of financial economics using mathematical terminology and English language.

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 are also useful:

1. "Investment Science" by D.G. Luenberger.
2. "Fundamentals of Corporate finance" by J. Berk, P. DeMarzo and J. Harford

6. Teaching and Learning Activities

Lectures (4 hours per week)

7. Tentative Course Schedule

Chapter 1: Bond immunization

- A quick review on bond pricing (using yield rate and term structure of interest rate)
- Duration and Convexity
- Bond investment analysis: Bond immunization and Contingent immunization
- Application of bond immunization in asset-liability management.

Chapter 2: Mean-Variance portfolio theory

- Mean and variance of portfolio return
- Markowitz's mean-variance formulation
- Two-fund theorem and one-fund theorem
- Risk-tolerance model

Chapter 3: Capital asset pricing model and performance analysis

- Capital asset pricing model (CAPM) and beta values
- Interpretations and uses of capital asset pricing model
- Investment performance analysis

Chapter 4: Utility optimization in investment decisions

- Axiomatic approach to the construction of utility function
- Maximum expected utility criterion
- Stochastic dominance (if time permitted)

8. Assessment Scheme

There are 2 assessment tasks in this course:

	Weight	CILOs assessed
Assignment	25% + Bonus	1, 2, 3, 4, 6, 7
Final examination	75%	1, 2, 3, 4, 5, 6, 7, 8

(a) Assignment (25% of the total grade + Bonus score)

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 of the optional problems for bonus score (which may improve your final grade).

(b) Final Examination (75% of the total grade)

It is a 2.5-3 hours closed book examination. The exam will cover **all** materials taught in the course. The exam schedule will be announced by ARR. The details of final exam will be formally announced in the last lecture of this course.

- ✓ No formula sheet or cheat sheet are allowed
- ✓ Standard calculators (Scientific or Financial calculators) are allowed.

*Note: You can pass the course for sure if you get at least 40% in overall total and get at least 25 points (out 100) in the final exam. On the other hand, you may fail the course if you cannot fulfil all criterions.