MATH4512 - Fundamentals of Mathematical Finance

Course outline - Spring 2015

1. Instructor
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2. Teaching assistant
   Name: Jiajun Guo
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3. Meeting time and Venue
   Date / time: Tuesday and Thursday (12:00noon – 13:20pm)
   Venue: Room 2502

4. Course description
   Credit points: 3
   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 portfolio analysis, capital asset pricing models, arbitrage pricing models, utility theory, stochastic dominance, asset pricing theory and valuation of contingent claims.

Prerequisite
No prior knowledge in finance is required. Familiarities with basic probability theory are absolutely necessary. You cannot take this course without taking an earlier course in Probability or Statistics. Basic topics include
   1. Probability distribution of a random variable [LECT1C; MATH246]
   2. Gaussian and Poisson distributions [LECT2B, LECT2C; MATH246]
   3. Moments of a single random variable [LECT2D; MATH246]
   4. Sum of several random variables [LECT3A, LECT3B, LECT3C; MATH246]

To review the materials by yourselves, please download the lecture notes from MATH246 – Probability and Random Processes.

Exclusion: Nil

5. Intended learning outcomes

   Upon successful completion of this course, students should be able to understand the following topics:
   • Mean-variance formulation of portfolio choices of risky assets and asset-liability models;
   • Asset pricing under the capital asset pricing models and factor models;
   • Portfolio choices under utility maximization and stochastic dominance;
   • Risk neutral valuation approach.

   In addition, students would also acquire the following abilities:
   1. Appreciate how to use quantitative tools to analyze issues related to portfolio choice problems and risk neutral valuation of contingent claims.
   2. Recognize the importance of applying rigorous and numerate approach to analyze and solve problem in financial economics.
3. Apply mathematical modeling and analytic proofs, as well as statistical analyses, to describe and explain phenomena in financial economics models.
4. Communicate the solutions of mathematical models of financial economics using mathematical terminology and English language.

6. Assessment scheme
   90-minute test 40%
   135-minute final examination 60%
   4 sets of homework 0%

   Proper submission of all homework sets may help improve a minor grade on marginal cases.

7. Student Learning Resources
   Lecture Notes:
   Lecture notes and references can be downloaded from the course home page.
   Reference text
   “Investment Science,” by D.G. Luenberger

8. Teaching and Learning Activities
   Scheduled activities: 3 hours of lecture per week

9. Course Schedule
   Week 1 – Week 3
   1. Mean variance portfolio theory
      1.1 Mean and variance of portfolio return
      1.2 Markowitz’s mean-variance formulation
      1.3 Two-fund theorem
      1.4 Inclusion of the risk free asset: One-fund Theorem
      1.5 Addition of risk tolerance factor
      1.6 Asset-liability model

   Week 4 – Week 6
   2. Capital asset pricing model and factor models
      2.1 Capital asset pricing model and beta values
      2.2 Interpretations and uses of capital asset pricing models
      2.3 Arbitrage pricing theory and factor models

   Week 7 – Week 10
   3. Utility theory and utility maximization for portfolio choices
      3.1 Optimal long-term investment criterion – log utility criterion
      3.2 Axiomatic approach to the construction of utility function
      3.3 Maximum expected utility criterion
      3.4 Characterization of utility functions
      3.5 Portfolio analysis under utility optimization
      3.6 Stochastic dominance

   Week 11 – Week 13
   4. Bond portfolio management and immunization
      4.1 Duration measures and convexity
      4.2 Horizon rate of return: return from the bond investment over a time period
      4.3 Immunization of bond investment