

## **MATH685X – Mathematical models in financial economics (Spring 2010)**

### *Course objective*

This course is directed to those students who would like to acquire an introduction to the fundamental principles in financial economics. Topics covered include utility theory and decision making under uncertainty, risk aversion and stochastic dominance, portfolio choice under utility maximization, Markowitz mean-variance portfolio theory, capital asset pricing models, arbitrage pricing theory and factor models, fundamental theorems on asset pricing.

### *Prerequisite and exclusion*

No prior knowledge in finance is required. Some knowledge in probability theory will be useful.

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### *Reference texts*

1. "Introduction to Mathematical Finance," S.R. Pliska.
2. "Finance theory," R.A. Jarrow.
3. "Theory of financial decision making," J. Ingersoll

### *Course topics*

1. Utility theory and decision making under uncertainty
  - 1.1 Maximum expected return criterion and St Peterburg's paradox
  - 1.2 Preference orderings and utility functions
    - 1.2.1 Preference relations
    - 1.2.2 Existence of utility
  - 1.3 Expected utility approach
    - 1.3.1 Choices among lotteries and maximum expected utility criterion
    - 1.3.2 Choices of probability distributions over outcomes
    - 1.3.3 Von Neumann – Morgenstern framework
    - 1.3.4 Allais paradox
2. Risk aversion and stochastic dominance
  - 2.1 Risk aversion
    - 2.1.1 Certainty equivalent and insurance premium
    - 2.1.2 Risk aversion coefficients
    - 2.1.3 Characterization of utility functions
  - 2.2 Stochastic dominance
    - 2.2.1 First order stochastic dominance
    - 2.2.2 Second order stochastic dominance
    - 2.2.3 Higher order stochastic dominance

3. Investment decision under utility maximization
  - 3.1 Two-asset portfolio analysis
    - Two-state model
  - 3.2 Multiple risky assets and riskfree asset
  - 3.3 Long-term growth and logarithm utility
4. Mean-variance portfolio analysis
  - 4.1 Mean-variance portfolio theory
  - 4.2 Two-fund theorem
  - 4.3 One-fund theorem
  - 4.4 Portfolio choices under utility optimization
5. Capital asset pricing models and arbitrage pricing theory
  - 5.1 Capital asset pricing models
  - 5.2 Risk decomposition
  - 5.3 Performance indexes
6. Arbitrage pricing theory
  - 6.1 Arbitrage pricing theory
  - 6.2 Factor models
7. Risk neutral valuation principles
  - 7.1 Asset span, law of one price and state prices
  - 7.2 Arbitrage opportunities and risk neutral measures
  - 7.3 Martingale pricing theory and valuation of contingent claims and
  - 7.4 Pricing of derivatives: forwards and swaps
    - 7.4.1 No-arbitrage price of forward
    - 7.4.2 Swap contracts
  - 7.5 Binomial pricing models for options
  - 7.6 Investment-consumption models
8. Equilibrium pricing and consumption allocations
  - 8.1 Arrow-Debreu securities markets
  - 8.2 Pareto consumption allocations
  - 8.3 Consumption-based capital asset pricing model