Course Syllabus: Optimization in Finance

--- Fall 2025 (First Semester in 2025--2026)

Course Name: Optimization in Finance
Course Serial ID: **0356**
Course ID: **106276**

Instructor: Sirong Luo
Office hour: Tuesday 15:30PM—17:00PM (or by appointment)
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Course Type: **Selective course for senior undergraduate student**

Couse Schedule: 2025/09/08 --- 2025/12/22
Monday afternoon 13:20PM-15:00PM Third Teaching Building 303
Final Exam Time: 2025/12/29 —2026/01/09

Teaching Hours:

Credit	Total Hours	Instructor Hours	Practical Hours	Experiment Hours	Other
2	**32**	**32**	**0**	**0**	**0**

Course Materials: https://canvas.shufe.edu.cn/courses/34951

Textbooks and Reference Books:
Assigned Textbook: 《Optimization Methods in Finance》Second Edition, Gerard Cornuejols, Javier Pena, Reha Tutuncu, Cambridge University Press, Inc, USA.
Referred Textbook:《Optimization in Operations Research》 Second Edition， Ronald L. Rardin，Pearson. USA

Preliminary knowledge:
This course is a selective course for senior students in statistics, finance and management. If students have mathematical foundations, such as advanced calculus, probability theory, optimization etc., it will be helpful for the study of this course. understand.

Prerequisite Courses: Probability theory, Statistics, Calculus, Operations Research

Teaching objectives:
Optimization in Finance is a selective course opened for all senior students in the university. It focuses on how to use optimization techniques to solve complex management problems in financial industry.
Knowledge objective: This course covers the most important optimization techniques which are widely used for challenging financial decision making in uncertain

environment. It includes linear programming, integer programming, quadratic programming, nonlinear programming, stochastic programming, dynamic programming and robust optimization. The students are required to understand the fundamental optimization theory and the related algorithms to solve the optimization models. Furthermore, the students are also required to learn some important finance topics, such as, asset and liability management, asset and option pricing, portfolio management, CVaR and volatility.

Capability objective: This course is intended for senior undergraduate students interested in applying optimization techniques in practice and research. After this course, students should be able to apply these optimization techniques to solve financial management problems. Specifically, students should be able to build right model for those complex financial decision problems, and apply related optimization algorithms to solve the model. Finally, the students should be able to interpret the results from optimization model, and derive good management insights from the results.

Value objective: This course focuses on teaching student to recognize the value of scientific approaches in decision making. While mastering mathematical models and finance knowledge, we also hope that students can draw insights from mathematical models and finance applications, and cultivate their scientific spirit, rational thinking ability and critical thinking for innovation. Moreover, we hope our students can improve their responsibility, moral character, and professional abilities, especially the ability to be realistic and pragmatic professional analytical skills as well as long-term planning and dedication.

Course knowledge requirements:

The students can register this course if they have fully mastered the knowledge of advanced calculus, probability theory, mathematical statistics and optimization concept. In addition, if students also have studied finance related courses, it will help master the practical skill of optimization modeling and problem analysis in finance industry.

The course requires students to master basic mathematical principles of commonly used optimization models. Through a combination of classroom explanations and practical application cases in financial industry, students can improve their ability to solve applied problems in finance management. Finally, in writing the final course paper, students can apply the knowledge learned to solve practical financial problems. Students are particularly required to understand the importance of seeking truth from facts and the importance of truth-seeking and pragmatism in making good decisions, master the ability of critical thinking and long-term planning in the study of mathematical models.

Course capability requirements:

As one of the selective courses for senior students in finance related majors, this course focuses on improving students' ability to apply optimization models to solve practical finance management problems, and specifically cultivates students' analytical abilities, modeling abilities, and the ability to solve financial decision-making problems. Students not only need to be able to convert complex finance management problems into optimization models, but also to be able to solve those decision-making models, find optimal solutions and derive management insights. This course is mainly taught through basic mathematical theory and financial case explanations, combined with extracurricular assignments, and supplemented by writing final finance optimization related paper. Through training, students should be able to have certain modeling and analysis capabilities, and the ability to apply decision-making optimization algorithms to solve those financial models. Students are expected to combine the background of specific finance problems and decision-making optimization modeling to give reasonable explanations for conclusions and guide practice. At the same time, in the course teaching process, we strive to cultivate students' moral character of seeking truth from facts and being united, friendly and cooperation.

Reading before class:

This course covers theoretical optimization methods and related applications in finance. Therefore, students are required to preview the course materials and be familiar with both mathematical optimization methods and relevant finance application before class. Students must read the relevant chapter course materials and be familiar with teaching content in advance. This will help to understand and master the course content proficiently, and improve the ability of applying optimization modeling and analysis.

Course Evaluation:

In addition to classroom teaching, we will also hold classroom discussions and case analysis on each chapter. After learning the basic content of each chapter, students need to be proficient in optimization algorithm theory and be able to apply SAS to model and solve optimal decisions. In addition, each student needs to participate in a team project and complete a practice-related application case, which must be submitted before the specified date. The students also need to take the final exam at the end of course. The proportion of each part to the total score is as follows:

Attendance	10%
Homework assignment	30%
Final paper	60%

Academic Honesty:

All students of the Shanghai University of Finance and Economics are responsible for knowing and adhering to the academic integrity policy of this university. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion).

Key Contents in Operations Research

Chapter 1: Introduction to Optimization Models
Types of Optimization Models
Financial Optimization Models
<u>[Ideological and political case]: understand the importance of seeking truth from facts and the importance of truth-seeking and pragmatism in making good decisions.</u>

Chapter 2: Linear Programming (LP): Theory& Algorithms
Algorithms for Linear Programming
Optimality Conditions
Duality
Sensitivity Analysis

Chapter 3: LP Model: Asset-Liability Model
Fixed Income Portfolio
Dedication & Immunization
Bonds & Cash Flow Problems

Chapter 4: LP Model: Arbitrage and Asset Pricing
Arbitrage Bonds
Asset Pricing: Binomial Pricing Model
Bond Portfolio Management

Chapter 5: Quadratic Programming (QP): Mean-Variance Model
Duality and Optimality Conditions
Algorithms & Sensitivity Analysis

Chapter 6: QP Model: Mean-Variance Model
Markowitz Mean-Variance Model
Analytical Solutions of Mean-Variance Model
Estimation of Inputs to Mean-Variance Model
Performance Analysis

Chapter 7: Sensitivity of Mean-Variance Model
Black-Litterman Model
Shrinkage Estimation
Robust Optimization

Chapter 8 & Chapter 9 Mixed Integer Programming: Portfolios with Constraints
Combinatorial Auctions
Constructing an Index Fund
Cardinality Constraints
Minimum Position Constraints
Risk-Parity Portfolios and Clustering
<u>[Ideological and political case]: Critical thinking and innovation.</u>

Chapter10 & Chapter 11: Stochastic Programming: Risk Measures
Stochastic Optimization Model
Two-Stage Stochastic Optimization
The L-Shaped Method
Risk Measures
Key Property of CVaR
Portfolio Optimization with CVaR

Chapter 12 & Chapter 13: Multi-Period Model
Bellman's Principle of Optimality
Linear-Quadratic Regulator
Sequential Decision Problem with Infinite Horizon
Kelly Criterion
Dynamic Portfolio Optimization
Execution Costs
[Ideological and political case]: long-term planning and dedication.

Chapter 14: Multi-Period Portfolio Optimization
Optimal Consumption and Investment
Dynamic Trading with transaction Costs
Dynamic Portfolio Optimization with Taxes

Chapter15: Dynamic Programming: Binomial Pricing Model
Binomial Lattice Model
Option Pricing
Option Pricing in Continuous Time

Chapter 16 & Chapter 17: Multi-Stage Stochastic Programming
Multi-Stage Stochastic Programming
Scenario Optimization and Generation
Asset-Liability Management
The Case of an Insurance Company
Option Pricing via Stochastic Programming

Chapter 19: Robust Optimization
Uncertain Sets
Techniques for Solving Robust Optimization Models
Robust Optimization Models in Finance
[Ideological and political case]: cultivate a rigorous and realistic attitude towards academic research.

Chapter 20: Nonlinear Programming
Optimality Conditions
Algorithms
Estimating a Volatility Surface