MATH4996 Capstone Project for Financial and Actuarial Mathematics
2026-2027 Fall Semester
Course Outline

Instructors

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Class Schedule
There is no regular lectures for this course. Students will attend the regular meetings scheduled by the project supervisor. Please discuss with your assigned project supervisor for the exact meeting schedule.

Course Description
This is a capstone project course for final-year students enrolled in FAM track. The students will form groups of 2-3 and conduct a research project on a topic in financial and actuarial mathematics.
The course will be divided into 3 main stages:

- Stage 1: Students meet the project supervisor regularly and work on the research project.
- Stage 2: Each group writes a written thesis summarizing all work done throughout the course.
- Stage 3: Each group needs to do an oral presentation on their research topic and answer the questions raised by the faculty members.

Grading Policy
Your grade of the capstone project will be determined by the following scheme:

1. **Continuous Assessment (20% of overall total)**
   All students are expected to participate actively throughout the project course (e.g. attending meetings as requested by the supervisor, submitting progress reports as requested by the supervisor). Each student will be graded individually by the project supervisor.

2. **Written Report (40% of overall total)**
   Each group is required to submit a final report summarizing all work done throughout the course. Please note that each group should write the report themselves without using AI. Each report will be graded by 3 instructors (Prof.

Leung, Prof. Deng and Prof. Qian). In general, students in the same group should receive the same score unless if there is any irregularities reported.

3. **Oral presentation (40% of overall total)**
   There will be an oral presentation near the end of the final exam period (The exact schedule will be finalized once the final exam timetable is confirmed).
   Part 1: Each group will need to do an oral presentation on their research topics (Not more than 40 minutes).
   Part 2: Each group need to answer the questions raised by the instructors.
   (*Note 1: Each student will be graded individually by 3 instructors. Therefore, we expect that all students should participate actively during the oral presentation. Also, each student needs to answer at least one question during Q&A session.)

We will adopt **criterion-referencing** in giving the final letter grade, i.e. your letter grade is given based on your own performance in the project course only.

Passing criterion: You can get a pass if you can achieve 40% or above in overall total.

- You can get A- or above if you can achieve 80% or above in overall total
- You can get B- or above if you can achieve 60% or above in overall total
- You can get C- or above if you can achieve 40% or above in overall total.

Policy on use of GenAI

Although the students may get some hints for the project using generative AI, the students are not allowed to use GenAI in writing the report or doing oral presentation. Please contact your project supervisor for further details on the use of genAI in your project.

Project Topics

These are the available topics for MATH4996. There are some prerequisites requirements for some projects

Project A1: Interest Rate Model Calibration	
Project Supervisor	Prof. Deng Shuoqing
Project Description	In this project, you are going to explore different interest rate models: short rate model(Hull-White model, Vasicek model) and forward rate model(HJM model, LMM model). You will study the connections between different models, how to price bond within different models, and most importantly, how to calibrate model parameters from the market data. At the end of the project, you are required to cover both the theoretical and practical side: derive the general pricing formulas, use real data to carry out the model calibration, or extend the study to additional interest rate models.
Prerequisites	B- or above in MATH4511 and MATH4514
Maximum number of groups	1

Project A2: From local volatility to stochastic volatility	
Project Supervisor	Prof. Deng Shuoqing
Project Description	In this project, you are going to explore the models outside the scope of Black-Scholes context: the volatility of the stock price is no longer constant but will depend on the stock price and maturity. You will explore the local volatility and Dupire's formula, and carry out the construction of volatility surface. You will also study the Heston model et al., and do the pricing of options under stochastic volatility models. At the end of the project, you are required to both produce outputs on the theoretical and numerical sides: understand the pricing and calibration of the models.
Prerequisites	B- or above in MATH4511 and MATH4514
Maximum number of groups	1

Project A3: Portfolio management beyond Markowitz

Project Supervisor	Prof. Deng Shuoqing
Project Description	In this project, you are going to apply your knowledge on Markowitz portfolio management and explore the real world Black-Litterman model. You will study the Beta plus Alpha approach widely applied in the industry and understand the ideas after Black-Litterman method. At the end of the project, you are required to apply the real market data to construct your portfolios both within Markowitz and Black-Litterman approach. You are expected to try to construct some clever alphas by yourself.
Prerequisites	B- or above in MATH4512
Maximum number of groups	1

Project B1: Asset Allocation Performance Forecasting	
Project Supervisor	Prof. Qian, Shuaijie
Project Description	In the world of systematic trading, asset allocations are everywhere — but signal quality is everything. Each day, traders are flooded with candidate allocations: portfolio constructions based on recent signals, liquidity flows, or historical patterns. Some of these portfolios will perform well in the next trading session. Others will underperform—or worse, underperform so consistently that shorting them might be the more profitable move. This project centers around a simple yet high-stakes question: Can you predict whether a given asset allocation is worth following — or shorting?
Prerequisites	B or above in MATH2511
Maximum number of groups	2

Project B2: Football Winner Guess	
Project Supervisor	Prof. Qian, Shuaijie
Project Description	Over the last two decades, professional sports around the world have adapted towards a data-driven approach to their decision-making. Sports analytics are part of live broadcasts, fantasy

	sports, and every-day discussions. This growth has been fueled by an exponential evolution in sports data. Data science and machine learning can be useful to tackle the growing field of sports analytics. It can be used by fantasy league players and professional gamblers alike to make better informed decisions. Sports betting websites have become quite sophisticated in this area in the last few years. Models can also be used by managers of professional sports teams and recruiters to build rosters and strategically deploy players in a way that increases the team's chance of winning. You will be provided with real historical data at the player, team and league level, and be asked to predict which team wins, or if there is a draw.
Prerequisites	B or above in MATH2511
Maximum number of groups	2

Project B3: Explain Price of Electricity	
Project Supervisor	Prof. Qian, Shuaijie
Project Description	Every day, a multitude of factors impact on the price of electricity. Local weather variations will affect both electricity generation and demand for instance. Long term phenomena, such as global warming, will also have a significant influence. Geopolitical events, such as the war in Ukraine, may affect in parallel the price of commodities, which are key inputs in electricity generation, knowing that each country relies on a particular energy mix (nuclear, solar, hydro, gas, coal, etc). Moreover, each country may import/export electricity with its neighbors through dynamical markets, like in Europe. These various elements make quite complex the modelisation of electricy price in a given country. The aim is to model the electricity price from weather, energy (commodities) and commercial data for two European countries - France and Germany. Let us stress that the problem here is to explain the electricity price with simultaneous variables and thus this is not a prediction problem.
Prerequisites	B or above in MATH2511

Maximum number of groups	2

Project C1: Numerical Algorithm for Derivative Pricing	
Project Supervisor	Prof. Leung, Chi Man
Project Description	Recall from MATH4514 that the Black-Scholes Model is one of the popular models for derivative pricing (although it is over simplified). In this project, we shall explore some basic numerical algorithms for pricing derivatives. This includes Lattice tree algorithm, Monte Carlo simulation and finite difference method. We shall explore some principles of these methods and conduct tests to compare the actual performance of these algorithms. At the end of the project, the students are required to apply these methods to price some complex financial derivatives.
Prerequisites	A passing grade in MATH4514
Maximum number of groups	2

Project C2: A further study on bond immunization	
Project Supervisor	Prof. Leung, Chi Man
Project Description	We studied the basic of bond immunization in MATH4512. The theory studied there is elementary and it is valid under a rather restrictive assumptions (e.g. flat term structure). There have been some research works which extends the theory to a more general setting. In this project, we shall study some of these extensions and examine the theories from that.
Prerequisites	A passing grade in MATH4512
Maximum number of groups	1

Project C3: Pricing of American option and its application	
Project Supervisor	Prof. Leung, Chi Man
Project Description	American options is an option which the holder has the right to exercise the option rights at any time before the maturity date. To price the American options, it is essential to determine the optimal exercising timing of the options (commonly known as

	exercising boundary). In this project, we shall explore the mathematical formulation of the pricing of American option under Black-Scholes model. After that, we explore the numerical algorithm (through stochastic control and policy iteration) for determining the price of American option. Alternatively, we also explore the application of American option in strategic decision making.
Prerequisites	Good grades in MATH4514 + Knowledge in basic calculus and linear algebra.
Maximum number of groups	2