MA6629: ADVANCED STOCHASTIC ANALYSIS IN FINANCE

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Advanced Stochastic Analysis in Finance

Subject Code
MA - Mathematics
Course Number
6629

Academic Unit
Mathematics (MA)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to introduce concepts and techniques in advanced probability theory and continuous time stochastic processes, as well as their applications to the real-world financial models in depth. It introduces measure-theoretic based stochastic calculus and builds up the connections with partial differential equations of Black-Scholes type.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Formulate measure-theoretic framework for probability theory required for a treatment of continuous time models.	20	x		
2	Introduce the Brownian motion and stochastic calculus using Ito's integral and the development of Ito's formula.	30	x	x	
3	Explain Girsanov's theorem and risk-neutral pricing, and introduce a systematic treatment of risk-neutral pricing and the Fundamental Theorems of Asset Pricing	25	x	x	x
4	Develop the connection between partial differential equation and stochastic calculus, and apply it to derivative pricing and risk hedging.	25	x	x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	teaching	Learning through teaching is primarily based on lectures.	1, 2, 3, 4	3 hours/week
2	take-home assignments	Learning through take-home assignments helps students implement advanced theory for better understanding	1, 2, 3, 4	After-class

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	1, 2	20	
2	Hand-in assignments	1, 2, 3, 4	10	

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

3

Additional Information for ATs

30% Coursework

70% Examination (Duration: 3 hours, at the end of the semester)

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task

1. Test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Problem solving ability on probability theory and stochastic analysis

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of the probability theory and stochastic analysis and applies them to complex financial problems

Good

(B+, B, B-) Adequately demonstrates an understanding of the probability theory and stochastic analysis and applies them to moderately complex financial problems

Fair

(C+, C, C-) Demonstrates some understanding of the probability theory and stochastic analysis and applies them to simple financial problems

Marginal

(D) Demonstrates limited understanding of the probability theory and stochastic analysis and has limited ability to apply them to simple financial problems

Failure

(F) Inappropriately or unable to apply modern statistical method for analysing time series data to solve financial problems

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Assessment Task

2. Hand-in assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Comprehensive understanding of statistical methods to solve financial problem

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of the probability theory and stochastic analysis and applies them to complex financial problems

Good

(B+, B, B-) Adequately demonstrates an understanding of the probability theory and stochastic analysis and applies them to moderately complex financial problems

Fair

(C+, C, C-) Demonstrates some understanding of the probability theory and stochastic analysis and applies them to simple financial problems

Marginal

(D) Demonstrates limited understanding of the probability theory and stochastic analysis and has limited ability to apply them to simple financial problems

Failure

(F) Inappropriately or unable to apply modern statistical method for analysing time series data to solve financial problems

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Assessment Task

3. Examinations (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Creativity and problem solving ability based on comprehensive understanding

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of the probability theory and stochastic analysis and applies them to complex financial problems

Good

(B+, B, B-) Adequately demonstrates an understanding of the probability theory and stochastic analysis and applies them to moderately complex financial problems

Fair

(C+, C, C-) Demonstrates some understanding of the probability theory and stochastic analysis and applies them to simple financial problems

Marginal

(D) Demonstrates limited understanding of the probability theory and stochastic analysis and has limited ability to apply them to simple financial problems

Failure

(F) Inappropriately or unable to apply modern statistical method for analysing time series data to solve financial problems

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Assessment Task

1. Test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Problem solving ability on probability theory and stochastic analysis

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of the probability theory and stochastic analysis and applies them to complex financial problems

Good

(B+, B) Adequately demonstrates an understanding of the probability theory and stochastic analysis and applies them to moderately complex financial problems

Marginal

(B-, C+, C) Demonstrates some understanding of the probability theory and stochastic analysis and applies them to simple financial problems

Failure

(F) Inappropriately or unable to apply modern statistical method for analysing time series data to solve financial problems

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Assessment Task

2. Hand-in assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Comprehensive understanding of statistical methods to solve financial problem

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of the probability theory and stochastic analysis and applies them to complex financial problems

Good

(B+, B) Adequately demonstrates an understanding of the probability theory and stochastic analysis and applies them to moderately complex financial problems

Marginal

(B-, C+, C) Demonstrates some understanding of the probability theory and stochastic analysis and applies them to simple financial problems

Failure

(F) Inappropriately or unable to apply modern statistical method for analysing time series data to solve financial problems

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Assessment Task

3. Examinations (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Creativity and problem solving ability based on comprehensive understanding

Excellent

(A+, A, A-) Demonstrates a comprehensive understanding of the probability theory and stochastic analysis and applies them to complex financial problems

Good

(B+, B) Adequately demonstrates an understanding of the probability theory and stochastic analysis and applies them to moderately complex financial problems

Marginal

(B-, C+, C) Demonstrates some understanding of the probability theory and stochastic analysis and applies them to simple financial problems

Failure

(F) Inappropriately or unable to apply modern statistical method for analysing time series data to solve financial problems

Part III Other Information

Keyword Syllabus

Brownian motion, Ito's formula, Stochastic differential equation, Girsanov theorem, Greeks

Reading List

Compulsory Readings

	Title
1	Course materials provided

Additional Readings

	Title
1	Stochastic Calculus for Finance II, by Steven Shreve, Springer, 2010
2	Arbitrage theory in continuous time, by Tomas Björk, Oxford University Press, 3rd edition