

MA5621: MATHEMATICAL METHODS FOR FINANCE AND ACTUARIAL SCIENCE

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Mathematical Methods for Finance and Actuarial Science

Subject Code

MA - Mathematics

Course Number

5621

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

The course provide an introduction of mathematical methods underlying Black-Scholes formula for option pricing, and familiarize students with concepts and techniques in advanced probability theory and stochastic calculus, as well as their applications to financial and actuarial problems.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain concepts on financial derivatives from advanced probability and stochastic calculus.	20	x	x	
2	Perform basic operations of discrete and continuous time processes.	20	x	x	x
3	Formulate financial phenomena in terms of Brownian motions and stochastic processes.	20	x	x	x
4	Describe Black-Scholes option pricing theory and its extensions quantitatively.	20	x	x	x
5	Apply mathematical methods to derive analytic relations among financial variables.	20	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, 5	3 hours/week
2	Take-home assignments	Learning through take-home assignments helps students implement advanced probability theory, stochastic processes, Black-Scholes option pricing theory as well as applications in modelling financial and actuarial markets.	1, 2, 3, 4, 5	After-class

Assessment Tasks / Activities (ATs)

ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?	
1	Test	1, 2, 3	20	Questions are designed for the first part of the course to see how well students have learned concepts of advanced probability, time processes, stochastic calculus and their applications in modelling financial phenomena.	No
2	Hand-in assignments	1, 2, 3, 4, 5	10	These are skills based assessment which enables students to implement methods and techniques of advanced probability, stochastic processes and some applications in finance and actuarial science.	Yes

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

3

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will primarily be skills and understanding based to access the student's versatility in probability theory and stochastic calculus.

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

Criterion

Comprehensive understanding of financial problem in terms of mathematical methods, including advanced probability and stochastic process

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can always apply the techniques to solve financial and actuarial problems

Good

(B+, B, B-) Adequately demonstrates an understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can usually apply the techniques to solve financial and actuarial problems

Fair

(C+, C, C-) Demonstrates some understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can sometimes apply the techniques to solve financial and actuarial problems

Marginal

(D) Demonstrates limited understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can seldom apply the techniques to solve financial and actuarial problems

Failure

(F) Demonstrates little understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can rarely or never apply the techniques to solve financial and actuarial problems

Assessment Task

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

Criterion

Real data analytic ability based on comprehensive understanding

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can always apply the techniques to solve financial and actuarial problems

Good

(B+, B, B-) Adequately demonstrates an understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can usually apply the techniques to solve financial and actuarial problems

Fair

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Failure

(F) Demonstrates little understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can rarely or never apply the techniques to solve financial and actuarial problems

Assessment Task

3. Examination (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-) Consistently demonstrates a thorough understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can always apply the techniques to solve financial and actuarial problems

Good

(B+, B, B-) Adequately demonstrates an understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can usually apply the techniques to solve financial and actuarial problems

Fair

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Failure

(F) Demonstrates little understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can rarely or never apply the techniques to solve financial and actuarial problems

Assessment Task

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

Criterion

Comprehensive understanding of financial problem in terms of mathematical methods, including advanced probability and stochastic process

Excellent

(A+, A, A-) Consistently demonstrates a thorough understanding of the concepts and techniques in the advanced probability theory and stochastic calculus and can always apply the techniques to solve financial and actuarial problems

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Assessment Task

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Part III Other Information

Keyword Syllabus

Parametric and nonparametric models; support vector machine; kernel machines; regularization; model averaging and aggregation; unsupervised learning; high-dimensional data

Reading List**Compulsory Readings**

Title	
1	Tools for Computational Finance by Rüdiger U. Seydel, Springer 4th Edition 2009

Additional Readings

Title	
1	An Introduction to Statistical Learning: with Application in R by James, Springer; 1st ed. 2013, Corr. 7th printing 2017 edition
2	Pattern Recognition and Machine Learning by Bishop, Springer, 2006
3	The Element of Statistical Learning by Hastie, Tibshirani and Friedman, Springer; 2nd edition
4	Mathematical Models of Financial Derivatives by Y. K. Kwok, Springer, 1998