EF3520: STOCHASTIC CALCULUS FOR FINANCE

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Stochastic Calculus for Finance

Subject Code
EF - Economics and Finance
Course Number
3520

Academic Unit
Economics and Finance (EF)

College/School
College of Business (CB)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
EF2452 Mathematics for Economics and Finance and
EF3450 Principles of Econometrics or MS4504 Statistics for Economic and Financial Modelling OR
MA1201 Calculus and Basic Linear Algebra II or MA1301 Enhanced Calculus and Linear Algebra II and
MA2506 Probability and Statistics

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course is designed to enhance students' mathematical ability, and equip them with the basic knowledge and skills of stochastic calculus for financial applications. Students will be introduced to stochastic processes, Brownian motion, and Ito calculus. Student will learn how to use quantitative analysis to derive the Black-Scholes formula for various types of options (European options, etc.). At the end of this course, students will be able to price various types of options and construct hedging strategies. The course also aims to develop students' creative and innovative abilities through various assessment tasks that involve the discovery and innovative process. Classes will encourage students to develop their discovery abilities through problem solving and class discussions. Stress will also be placed on common pricing and hedging problems in global financial markets to help students to discover the basic knowledge in the finance industry. Assignments will require students to discover and innovate through the use of mathematical concepts. Students will get to know how to use these theories to come up with their own analyses on different financial products. The final exam which covers topics discussed in the lectures will reveal the students' accomplishments in discovery and innovation.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Justify and apply the theory and in the modelling of stochastic processes. Describe the rationale behind the quantitative analysis.	25	x	x	x
2	Justify and explain discrete time models and Brownian motion equations to address financial problems and construct innovative solutions.	20	x	x	x
3	Justify and apply Ito's calculus and derive Ito's formula to solve stochastic differential equations with innovative insights.	20	x	x	
4	Derive the Black-Scholes Formula by using partial differential equations (PDEs). Discuss the logic behind the Black-Scholes Formula.	25	x		
5	Apply delta and gamma hedging strategies and generate innovative solutions for risk management problems.	10	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	Lectures	Students will engage in lectures to gain knowledge about basic concepts and structure. Students will develop an in-depth understanding of the theory of stochastic calculus and asset valuation modeling, followed by the hedging functions of various financial products.	1, 2, 3, 4, 5	3 hours per week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments Students will perform analyses on various modelling problems. They will be required to apply mathematical theories to generate innovative solutions for certain problems facing the finance industry.	1, 2, 3, 4, 5	50	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

3

Additional Information for ATs

Students are required to pass both coursework and examination components in order to pass the course.

Assessment Rubrics (AR)

Assessment Task

Final Examination (3 hours)

Criterion

Ability to apply the theory of stochastic calculus and explain its concepts

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Assignments

Criterion
Capacity for discovering/ deriving results complementing the theory of stochastic calculus covered by the lectures and for applying the theory

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus
1. Partial Differential Equations
2. Two-instants model
3. N-instants model
4. Self-financing portfolio
5. Risk neutral measure
6. Arbitrage opportunity
7. Market completeness
8. Filtration
9. Brownian motion
10. Stochastic processes
11. Itô formula
12. Black-Scholes Formula
13. Delta hedging
14. Gamma hedging

Reading List

Compulsory Readings

	Title
1	An Introduction to Derivative Pricing, by Martin Baxter & Andrew Rennie, Cambridge University Press

Additional Readings

	Title
1	Elementary Stochastic Calculus – with Finance in View, by Thomas Mikosch, World Scientific
2	Introduction to Stochastic Calculus with Applications, by Fima C. Klebaner Imperial College Press