ST908-15 Stochastic Calculus for Finance

21/22

Department
Statistics
Level
Taught Postgraduate Level
Module leader
Martin Herdegen
Credit value
15
Module duration
10 weeks
Assessment
20% coursework, 80% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This module runs in Term 1 and is core for students on the MSc in Mathematical Finance.
PhD students interested in taking the module should consult the module leader.
This module is not available to undergraduate students.

Module web page

Module aims

This module provides a thorough introduction into discrete-time martingale theory, Brownian motion, and stochastic calculus, illustrated by examples from Mathematical Finance.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

1 Conditional expectations
(a) Elementary conditional expectations

(b) Measure-theoretic conditional expectations
(c) Properties of conditional expectations
2 Martingale Theory
(a) Stochastic processes and filtrations
(b) Martingales, submartingales, and supermartingales
(c) Discrete stochastic integral
(d) Stopping times and stopping theorem
(e) Martingale convergence theorems
(1) Applications to Finance (option pricing in complete markets)
3 Markov Processes
(a) Markov processes and Markov property
(b) Strong Markov property
4) Brownian motion and continuous local martingales
(a) Definition and fundamental properties of Brownian
(b) Quadratic variation
(c) Continuous local martingales and semimartingales
5) Stochastic calculus
(a) Integration with respect to local martingales
(b) Finite variation processes and Lebesgue-Stieljes integration
(c) Integration with respect to semimartingales
(d) Ito's formula
(e) Levy's characterisation of Brownian motion
(f) Stochastic exponentials and Novikov's condition

(g) Girsanov's theorem
(h) Ito representation theorem
(i) Feynman-Kac formula
(j) Applications to Finance (Black Scholes model)
6) Stochastic differential equations
(a) Strong solutions and Lipschitz-theory
(b) Examples (0U-processes, CIR processes, etc.)

Learning outcomes

By the end of the module, students should be able to:

- Explain and apply the concept of measure-theoretic conditional expectations
- Demonstrate an understanding of discrete time martingale theory and apply the theory to option pricing
- Understand the basic properties of Brownian motions
- Explain the main steps in the construction of the stochastic integral
- Be proficient in applying Ito's formula and Girsanov's theorem in problems arising in Mathematical Finance
- Solve standard SDEs appearing in Mathematical Finance

Indicative reading list

View reading list on Talis Aspire

Subject specific skills

-Explain and apply the concept of measure theoretic conditional expectations
Show an understanding of martingales and the connection with gains from trade
-Understand the Markov property and the strong Markov property and apply it to examples
-Demonstrate the ability to perform calculations involving martingales and stochastic integrals
-Be proficient in applying Ito's formula and Girsanov's theorem to problems in Mathematical finance
-Demonstrate the ability to translate problems from mathematics to finance and vice-versa

Transferable skills

-Demonstrate problem solving skills involving concepts from the module

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Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Tutorials	10 sessions of 1 hour (7%)
Private study	110 hours (73%)
Total	150 hours

Private study description

Weekly revising of lecture notes and materials, solving of problem sheets, and preparing for class tests and the final exam.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D2

	Weighting	Study time
Class Test 1 (20-minute synchronous online	10%	

	Weighting	Study time
assessment) This class test takes place in the middle of the term during a lecture.		
Class Test 2 (20-minute synchronous online assessment) This class test takes place in the middle of the term during a lecture.	10%	
Locally Timetabled Examination The examination paper will contain four questions, of which the best marks of THREE questions will be used to calculate your grade.	80%	

Feedback on assessment

Solutions and written cohort level feedback will be provided for the final exam. Oral cohort level feedback will be provided for the class tests.

Scripts are retained for external examiners and will not be returned to you.

Past exam papers for ST908

Availability

Courses

This module is Core for:

- Year 1 of TIBS-N3G1 Postgraduate Taught Financial Mathematics