ST339-15 Introduction to Mathematical Finance

26/27

Department
Statistics
Level
Undergraduate Level 3
Module leader
Elke Thonnes
Credit value
15
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This module is available for students on a course where it is a listed option and as an Unusual Option to students who have the required knowledge as covered by the pre-requisite modules.

Pre-requisites

- Statistics Students:
    - ST228 Mathematical Methods for Statistics and Probability and ST229 Probability for Mathematical Statistic.
- Non-Statistics Students:
    - ST232/ST233 Introduction to Mathematical Statistics or ST352 Introduction to Mathematical Statistics (for Finalists).

Knowledge requirements. This module uses certain measure-theoretic and probabilist ideas seen in MA359 Measure theory or ST350 Measure Theory for Probability. The module ST339 is thus complemented by knowledge acquired in these modules and these modules help students comprehend and learn the material in ST339 more effectively. It is therefore **strongly**

recommended to take either MA359 Measure theory or ST350 Measure Theory for Probability alongside this module. If you do not take MA359 Measure theory or ST350 Measure Theory for Probability then you will be required to study the required concepts yourself.

Results from this module will be partly used to determine exemption eligibility in the Institute and Faculty of Actuaries (IFoA) module CM2.

This module serves as a prerequisite for ST401 Stochastic Methods in Finance, IB357 Investment Management
IB359 Derivatives and Risk Management, IB394 International Financial Management and EC334 Topics in Financial Economics: Corporate Finance and Markets.

For anti-requisite modules please check under the availability tab and in the course handbook.

Module web page

Module aims

To provide an introduction to Mathematical Finance in discrete time and cover the discrete part of the actuarial syllabus.

To be able to evaluate and interpret the theory of mathematical finance in discrete time and to apply theoretical concepts to construct stochastic models of financial markets.

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. No-Arbitrage and the Fundamental Theorem of Asset Pricing
   a) Mathematical model for one period financial markets
   b) Trading strategies and arbitrage opportunities
   c) Discounting and Equivalent Martingale Measures
   d) The Fundamental Theorem of Asset Pricing
2. Mean-Variance Portfolio Selection and the CAPM
   a) The return of an asset and of a portfolio
   b) Maximising the expected return
   c) The mean-variance problems
   d) The case without a riskless asset
   e) The case with a riskless asset
   f) The Markowitz tangency portfolio and the capital market line
   g) Mean-variance equilibria
   h) The Capital Asset Pricing Model (CAPM)
3. Utility Theory
   a) Preferences on lotteries
   b) Von Neumann-Morgenstern representation
   c) Concave functions and Jensen’s inequality
   d) Expected utility representation
   e) Measuring risk aversion

   d) A primer on utility maximisation
4. Introduction to Risk Measures
   a) Monetary measures of risk
   b) Value at Risk and Expected Shortfall
5. Pricing and Hedging in Finite Discrete Time
   a) Conditional expectations
   b) Filtrations and martingales
   c) Financial markets in finite discrete time
   d) Self-financing strategies
   e) The Fundamental Theorem of Asset Pricing revisited
   f) Valuation of contingent claims
   g) Complete markets
   h) Pricing and hedging in the binomial model

Learning outcomes

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

- Understand key notions of arbitrage and equivalent martingale measures in a one period financial market; calculate the set of equivalent martingale measures in a financial market
- Solve the mean-variance problems, understand the concept of the capital market line, describe the Capital Asset Pricing model including the principal results and assumptions
- Describe preference orders of financial investors, explain the concept of risk aversion, solve simple utility maximisation problems
- Explain the modern concept of monetary measures of risk, calculate the Value at Risk and Expected Shortfall for given distributions
- Model financial markets in finite discrete time, describe self-financing strategies and absence of arbitrage, hedge derivative products in complete and incomplete markets in discrete time

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Subject specific skills

- Demonstrate facility with rigorous probabilistic methods.
- Evaluate, select and apply appropriate mathematical and/or probabilist techniques.
- Demonstrate knowledge of and facility with formal probability concepts, both explicitly and by applying them to the solution of finance problems.
- Create structured and coherent arguments communicating them in written form.
- Construct logical mathematical arguments with clear identification of assumptions and conclusions.

- Reason critically, carefully, and logically and derive (prove) mathematical results.

Transferable skills

- Problem solving: Use rational and logical reasoning to deduce appropriate and well-reasoned conclusions. Retain an open mind, optimistic of finding solutions, thinking laterally and creatively to look beyond the obvious. Know how to learn from failure.
- Self awareness: Reflect on learning, seeking feedback on and evaluating personal practices, strengths and opportunities for personal growth.
- Communication: Present arguments, knowledge and ideas, in a range of formats.
- Professionalism: Prepared to operate autonomously. Aware of how to be efficient and resilient. Manage priorities and time. Self-motivated, setting and achieving goals, prioritising tasks.

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Tutorials	5 sessions of 1 hour (3%)
Private study	115 hours (77%)
Total	150 hours

Private study description

Weekly revision of lecture notes and materials, wider reading, practice exercises and preparing for examination.

Other activity description

Revision support.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B7

	Weighting	Study time	Eligible for self-certification
Centrally-timetabled examination (On-campus)	100%		No

The examination paper will contain four questions, of which the best marks of THREE questions will be used to calculate your grade.

- Answerbook Pink (12 page)

Assessment group R6

	Weighting	Study time	Eligible for self-certification
In-person Examination - Resit	100%		No

The examination paper will contain four questions, of which the best marks of THREE questions will be used to calculate your grade.

- Answerbook Pink (12 page)

Feedback on assessment

Solutions and cohort level feedback will be provided for the examination.

Past exam papers for ST339

Availability

Anti-requisite modules

If you take this module, you cannot also take:

- EC333-15 Topics in Financial Economics: Theories and International Finance
- IB3FP-15 Principles of Finance (for Finalists)
- IB253-15 Principles of Finance 1

Courses

This module is Optional for:

- USTA-G302 Undergraduate Data Science
  - Year 3 of G302 Data Science
  - Year 3 of G302 Data Science
- Year 3 of USTA-G304 Undergraduate Data Science (MSci)
- Year 3 of USTA-G305 Undergraduate Data Science (MSci) (with Intercalated Year)
- Year 3 of USTA-G303 Undergraduate Data Science (with Intercalated Year)
- UCSA-G4G1 Undergraduate Discrete Mathematics
  - Year 3 of G4G1 Discrete Mathematics
  - Year 3 of G4G1 Discrete Mathematics
- UCSA-G4G3 Undergraduate Discrete Mathematics
  - Year 3 of G4G1 Discrete Mathematics
  - Year 3 of G4G3 Discrete Mathematics
- Year 3 of UCSA-G4G4 Undergraduate Discrete Mathematics (with Intercalated Year)
- Year 3 of UCSA-G4G2 Undergraduate Discrete Mathematics with Intercalated Year
- Year 3 of UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
- USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
  - Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
  - Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
  - Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
- Year 3 of USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated
- UMAA-G100 Undergraduate Mathematics (BSc)
  - Year 3 of G100 Mathematics
  - Year 3 of G100 Mathematics
  - Year 3 of G100 Mathematics
- UMAA-G103 Undergraduate Mathematics (MMath)
  - Year 3 of G100 Mathematics
  - Year 3 of G103 Mathematics (MMath)
  - Year 3 of G103 Mathematics (MMath)
- Year 4 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 3 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 3 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)
- USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
  - Year 3 of GG14 Mathematics and Statistics
  - Year 3 of GG14 Mathematics and Statistics
  - Year 4 of GG14 Mathematics and Statistics
  - Year 4 of GG14 Mathematics and Statistics
- USTA-GG17 Undergraduate Mathematics and Statistics (with Intercalated Year)
  - Year 3 of GG17 Mathematics and Statistics (with Intercalated Year)
  - Year 4 of GG17 Mathematics and Statistics (with Intercalated Year)
- Year 3 of UMAA-G101 Undergraduate Mathematics with Intercalated Year
- USTA-Y602 Undergraduate Mathematics,Operational Research,Statistics and Economics
  - Year 3 of Y602 Mathematics,Operational Research,Stats,Economics

    - Year 3 of Y602 Mathematics,Operational Research,Stats,Economics
- Year 3 of USTA-Y603 Undergraduate Mathematics,Operational Research,Statistics,Economics (with Intercalated Year)