

# ST338-15 Actuarial Models

**26/27**

**Department**

Statistics

**Level**

Undergraduate Level 3

**Module leader**

Joan Nakato

**Credit value**

15

**Module duration**

10 weeks

**Assessment**

Multiple

**Study location**

University of Warwick main campus, Coventry

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## Description

### Introductory description

This module introduces the modelling techniques employed by actuaries. This module brings together a range of statistical techniques including stochastic processes, Markov chains, Survival models, estimation, maximum likelihood estimators and life tables to cover actuarial areas such as risk modelling, survival analysis and actuarial mathematics. It thus offers the opportunity to see how statistics is employed in an actuarial and thus authentic setting.

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 background as specified in the pre-requisite modules.

**Pre-requisites:**

- Statistics Students:
  - ST227 Stochastic Processes, and ST228 Mathematical Methods for Statistics and Probability, and ST229 Probability for Mathematical Statistics, and ST230 Mathematical Statistics.
- Non-Statistics Students:
  - ST121 Statistical Laboratory, AND
  - ST227 Stochastic Processes, AND
  - ST232/ST233 Introduction to Mathematical Statistics or ST352 Introduction to

## Mathematical Statistics (for Finalists).

**Useful background.** Students taking this module may benefit from taking ST346 Generalised Linear Models for Regression and Classification since it may help students comprehend or learn the material more effectively but it is not required to study this module.

Results from this module may be partly used to determine exemption eligibility in the Institute and Faculty of Actuaries (IFoA) modules CS2 and CM1. (Independent application with the IFoA may be required to receive the exemption.)

[Module web page](#)

## Module aims

To cover part of the syllabus for Institute of Actuaries exam CS2.

## 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.

This module covers the following actuarial areas:

- Principles of actuarial modelling
- Principles of stochastic processes
- Markov chains and Markov jump processes
- Survival models: lifetimes, curtate future lifetime, expected value and variance.
- Estimation procedures for lifetime distributions: Kaplan—Meier estimate, Cox model
- Multi-state Markov models.
- Maximum likelihood estimators for transition intensities in multi-state models.
- Estimation in the Markov Model.
- Estimating mortality rates by age: exact methods, census approximations
- Process of graduation.
- Statistical tests for life tables.

## Learning outcomes

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

- Describe the principles of actuarial modelling
- Describe the general principles of stochastic processes and their classification into different types.
- Define and apply a Markov chain.
- Define and apply a Markov jump process.
- Explain the concept of survival models.
- Describe estimation procedures for lifetime distributions
- Derive maximum likelihood estimators for the transition intensities in models of transfers

between states with piecewise constant transition intensities.

- Describe the two-state model of a single decrement and compare its assumptions with those of the random lifetime model, derive maximum likelihood estimators for transition intensities and state the Poisson approximation to the estimator in the case of a single decrement.
- Describe how to estimate transition intensities depending on age, exactly or using the census approximation.
- Describe how to test crude estimates for consistency with a standard table or set of graduated estimates and describe the process of graduation.
- Explain heterogeneity in populations, and simple methods to deal with heterogeneity.

## Indicative reading list

[Specific reading list for the module](#)

## Interdisciplinary

Students learn beyond the boundary of statistics and probability connecting their learning with the professional expectations of the chartered professional body dedicated to educating, developing and regulating actuaries based both in the UK and internationally.

## Subject specific skills

- Demonstrate facility with mathematical, probabilistic and statistical methods.
- Select and apply appropriate mathematical and/or statistical techniques.
- Demonstrate knowledge of key mathematical and statistical concepts, both explicitly and by applying them to the solution of finance and financial problems.
- Create structured and coherent arguments communicating them in written form.
- Reason critically, carefully, and logically and derive judgements to support recommendations.

## 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.

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## Study

### Study time

Type	Required
Lectures	28 sessions of 1 hour (19%)
Tutorials	8 sessions of 1 hour (5%)
Private study	62 hours (41%)
Assessment	52 hours (35%)
Total	150 hours

### Private study description

Weekly revision of lecture notes and materials, wider reading of actuarial syllabus, practice exercises and preparing for class tests and the examination.

### Other activity description

Revision support equivalent to approximately 2 hours.

### Costs

No further costs have been identified for this module.

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## Assessment

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

Students can register for this module without taking any assessment.

### Assessment group D7

	Weighting	Study time	Eligible for self-certification
Computer Based Assessment 1	10%	15 hours	Yes (waive)
Computer based assessment which will take place at a fixed time during the term that the module is delivered.			
Computer Based Assessment 2	10%	15 hours	Yes (waive)
Computer based assessment which will take place at a fixed time during the term that the module			

	<b>Weighting</b>	<b>Study time</b>	<b>Eligible for self-certification</b>
is delivered.			
Assessment	10%	22 hours	Yes (extension)
A computer-based assessment of practical aspects of the module covering CS2B exemption.			
Centrally-timetabled examination (On-campus)	70%		No
You will be required to answer all questions on this examination paper.			

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- Formulae & Tables for Examinations (Inst of Actuaries 2002) GOLD HARDBACK BOOK
- Students may use a calculator
- Answerbook Pink (12 page)

### Assessment group R6

	<b>Weighting</b>	<b>Study time</b>	<b>Eligible for self-certification</b>
In-person Examination - Resit	100%		No
You will be required to answer all questions on this examination paper.			

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- Answerbook Pink (12 page)
- Students may use a calculator
- Formulae & Tables for Examinations (Inst of Actuaries 2002) GOLD HARDBACK BOOK

### Feedback on assessment

Solutions and/or commentary and cohort level feedback will be provided for the class tests and examinations.

[Past exam papers for ST338](#)

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## Availability

### Courses

This module is Optional for:

- USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics

- Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
- Year 4 of G300 Mathematics, Operational Research, Statistics and Economics
- Year 5 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)

This module is Option list A for:

- USTA-G301 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics (with Intercalated
  - Year 3 of G30E Master of Maths, Op.Res, Stats & Economics (Actuarial and Financial Mathematics Stream) Int
  - Year 4 of G30E Master of Maths, Op.Res, Stats & Economics (Actuarial and Financial Mathematics Stream) Int
- Year 3 of USTA-Y602 Undergraduate Mathematics, Operational Research, Statistics and Economics
- Year 4 of USTA-Y603 Undergraduate Mathematics, Operational Research, Statistics, Economics (with Intercalated Year)

This module is Option list B for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
  - Year 4 of G105 Mathematics (MMath) with Intercalated Year
  - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- Year 3 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics
- Year 3 of UMAA-G100 Undergraduate Mathematics (BSc)
- UMAA-G103 Undergraduate Mathematics (MMath)
  - Year 3 of G100 Mathematics
  - Year 3 of G103 Mathematics (MMath)
  - Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G107 Undergraduate Mathematics (MMath) with Study Abroad
- Year 4 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercalated Year

This module is Option list D for:

- Year 3 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 4 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)

This module is Option list F for:

- Year 4 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics