



## UNSW Course Outline

# ACTL2102 Foundations of Actuarial Models - 2024

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## General Course Information

**Course Code :** ACTL2102

**Year :** 2024

**Term :** Term 3

**Teaching Period :** T3

**Is a multi-term course? :** No

**Faculty :** UNSW Business School

**Academic Unit :** School of Risk and Actuarial Studies

**Delivery Mode :** In Person

**Delivery Format :** Standard

**Delivery Location :** Kensington

**Campus :** Sydney

**Study Level :** Undergraduate

**Units of Credit :** 6

### Useful Links

[Handbook Class Timetable](#)

## Course Details & Outcomes

### Course Description

This course introduces the stochastic models used by actuaries to model both liabilities and assets and illustrates their applications in actuarial work. Topics covered include discrete-time and continuous-time Markov chains and their applications to experience rating; Markov process

models and applications to actuarial modelling practice including in areas such as insurance, financial risk, and social policy; methods for simulation of a stochastic process; estimation of Markov chains. Students will be expected to implement models using the R software in a numerical computer package.

## Course Aims

This course provides an introduction to the stochastic models used by actuaries to model both liabilities and assets and illustrates their applications in actuarial work.

## Relationship to Other Courses

This course introduces the stochastic models used by actuaries to model both liabilities and assets and illustrates their applications in actuarial work. The material is mathematically rigorous with a strong foundation in mathematics. The required knowledge of the course is a good understanding of probability and statistics as covered in ACTL2131 Probability and Mathematical Statistics or MATH2801 and MATH2831. You should also be proficient with calculus and linear algebra. The assumed knowledge of the course is a good understanding of mathematics as covered in MATH1151 and MATH1251.

The course will have applications in other courses in the actuarial major. More advanced models are covered in ACTL3141 Modelling and Prediction of Life and Health Related Risks and ACTL3162 General Insurance Techniques. The course is necessary knowledge for the more advanced coverage in ACTL3141 Modelling and Prediction of Life and Health Related Risks, ACTL3151 Actuarial Mathematics for Insurance and Superannuation, ACTL3162 General Insurance Techniques, and ACTL3182 Asset-Liability and Derivative Models. Advanced data analytics methods relevant to actuarial work are covered in ACTL3142 Statistical Machine Learning for Risk and Actuarial Applications.

# Course Learning Outcomes

Course Learning Outcomes	Program learning outcomes
CLO1 : Define key principles of actuarial modeling.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO2 : Explain terminologies and classifications of stochastic processes.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO3 : Identify features and properties of Markov Chains.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO4 : Apply Markov Chains to frequency-based NCD schemes using data.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO5 : Describe and utilize Markov Processes in insurance and financial models.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO6 : Evaluate Markov processes in financial and insurance modeling.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO7 : Implement Monte Carlo simulations for stochastic processes.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO8 : Use Monte Carlo simulations in simple actuarial problems.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO9 : Estimate transition probability and matrix of discrete-time and continuous-time Markov chains.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO10 : Discuss actuarial models with an understanding of their ethical implications.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO11 : Present complex actuarial models effectively in written form.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>
CLO12 : Produce professionally structured reports based on actuarial modelling.	<ul style="list-style-type: none"><li>• PLO1 : Business Knowledge</li><li>• PLO2 : Problem Solving</li><li>• PLO3 : Business Communication</li></ul>

Course Learning Outcomes	Assessment Item
CLO1 : Define key principles of actuarial modeling.	<ul style="list-style-type: none"> <li>• Formative assessment</li> <li>• Examination</li> </ul>
CLO2 : Explain terminologies and classifications of stochastic processes.	<ul style="list-style-type: none"> <li>• Formative assessment</li> <li>• Examination</li> </ul>
CLO3 : Identify features and properties of Markov Chains.	<ul style="list-style-type: none"> <li>• Individual project</li> <li>• Formative assessment</li> <li>• Examination</li> </ul>
CLO4 : Apply Markov Chains to frequency-based NCD schemes using data.	<ul style="list-style-type: none"> <li>• Individual project</li> <li>• Formative assessment</li> <li>• Examination</li> </ul>
CLO5 : Describe and utilize Markov Processes in insurance and financial models.	<ul style="list-style-type: none"> <li>• Formative assessment</li> <li>• Examination</li> </ul>
CLO6 : Evaluate Markov processes in financial and insurance modeling.	<ul style="list-style-type: none"> <li>• Examination</li> </ul>
CLO7 : Implement Monte Carlo simulations for stochastic processes.	<ul style="list-style-type: none"> <li>• Individual project</li> <li>• Examination</li> </ul>
CLO8 : Use Monte Carlo simulations in simple actuarial problems.	<ul style="list-style-type: none"> <li>• Individual project</li> <li>• Examination</li> </ul>
CLO9 : Estimate transition probability and matrix of discrete-time and continuous-time Markov chains.	<ul style="list-style-type: none"> <li>• Examination</li> </ul>
CLO10 : Discuss actuarial models with an understanding of their ethical implications.	<ul style="list-style-type: none"> <li>• Individual project</li> <li>• Examination</li> </ul>
CLO11 : Present complex actuarial models effectively in written form.	<ul style="list-style-type: none"> <li>• Individual project</li> <li>• Examination</li> </ul>
CLO12 : Produce professionally structured reports based on actuarial modelling.	<ul style="list-style-type: none"> <li>• Individual project</li> <li>• Examination</li> </ul>

## Learning and Teaching Technologies

Moodle - Learning Management System | EdStem | Echo 360

## Learning and Teaching in this course

The course website is available on Moodle: <https://moodle.telt.unsw.edu.au/login/index.php> or via [my.unsw.edu.au](http://my.unsw.edu.au).

All course contents will be available from the Moodle course website. It is essential that you visit the site regularly to see any announcements posted by the LIC, as it will be assumed that they are known to you within a reasonable time.

Students are expected to attend lectures and tutorials in person. The lectures focus more on the fundamental concepts/theory and the derivation of important results, and some examples will

also be given. During the weekly lecture, the LIC will go through the lecture slides in detail and provide further explanations and annotations, and students will also have the opportunity to ask questions on aspects of the course that need further clarification. Although lectures are supposed to be automatically recorded by the system and made available on Moodle, the lecture recordings are never meant to be replacement of in-person lectures. There are occasionally technical issues of the recording system regarding the availability and the quality of the recordings, and in such cases it is not the LIC's responsibility to redeliver the lecture or supply a replacement recording.

On the other hand, tutorial exercises let you practice solving the related problems/questions by applying the concepts and theory learnt from class. In the tutorials, students have the chance to interact with the tutor and other students in the course. Students are expected to attempt the tutorial exercises prior to the tutorial classes and identify problems that require closer review during tutorials. The tutorials present an opportunity to learn from other students and to develop team skills by working on problems with other students. Tutorials are not recorded.

## Assessments

### Assessment Structure

Assessment Item	Weight	Relevant Dates	Program learning outcomes
Formative assessment Assessment Format: Individual Short Extension: Yes (1 day)	15%		<ul style="list-style-type: none"><li>PLO1 : Business Knowledge</li><li>PLO2 : Problem Solving</li><li>PLO3 : Business Communication</li></ul>
Individual project Assessment Format: Individual Short Extension: Yes (7 days)	25%		<ul style="list-style-type: none"><li>PLO1 : Business Knowledge</li><li>PLO2 : Problem Solving</li><li>PLO3 : Business Communication</li></ul>
Examination Assessment Format: Individual	60%		<ul style="list-style-type: none"><li>PLO1 : Business Knowledge</li><li>PLO2 : Problem Solving</li><li>PLO3 : Business Communication</li></ul>

### Assessment Details

#### Formative assessment

##### Assessment Overview

These are aimed at encouraging students to keep up with the course materials.

##### Course Learning Outcomes

- CLO1 : Define key principles of actuarial modeling.
- CLO2 : Explain terminologies and classifications of stochastic processes.

- CLO3 : Identify features and properties of Markov Chains.
- CLO4 : Apply Markov Chains to frequency-based NCD schemes using data.
- CLO5 : Describe and utilize Markov Processes in insurance and financial models.

### Detailed Assessment Description

There will be two online quizzes (7.5% each) which will take place on the Moodle platform. Each quiz will take about one hour to complete, and students will be given a 3-day window to work on the quiz. Full credit will be awarded based on a genuine attempt. Tentatively, the quizzes will take place in Week 5 and in Week 10 (TBC).

### Assessment Length

3 days each

### Submission notes

Submission via Moodle quiz platform

### Assignment submission Turnitin type

This is not a Turnitin assignment

### Generative AI Permission Level

#### **Simple Editing Assistance**

In completing this assessment, you are permitted to use standard editing and referencing functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.

If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.

For more information on Generative AI and permitted use please see [here](#).

### **Individual project**

### Assessment Overview

An assignment task involving application of course concepts.

### Course Learning Outcomes

- CLO3 : Identify features and properties of Markov Chains.
- CLO4 : Apply Markov Chains to frequency-based NCD schemes using data.
- CLO7 : Implement Monte Carlo simulations for stochastic processes.

- CLO8 : Use Monte Carlo simulations in simple actuarial problems.
- CLO10 : Discuss actuarial models with an understanding of their ethical implications.
- CLO11 : Present complex actuarial models effectively in written form.
- CLO12 : Produce professionally structured reports based on actuarial modelling.

#### **Detailed Assessment Description**

The practical application of the course concepts based on actual stochastic modelling problems is an important graduate attribute that employers require and this course aims to provide at least some introductory exposure to this. Writing skills for technical material are also important.

The assignment will involve the use of R to solve real life insurance/financial problems involving stochastic modelling. This will provide students with an opportunity to develop communication and computational skills. It offers students the opportunity to engage in independent research, engage in critical analysis, and problem solving, as well as to demonstrate their understanding of the concepts and perspectives that are central to actuarial studies. Tentatively, the assignment will be due in Week 9 (TBC). The assignment will be made available at least two weeks before the due date, and students need to complete the assignment by submitting both a report and the original R code.

#### **Assessment Length**

At least 2 weeks

#### **Assignment submission Turnitin type**

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

#### **Generative AI Permission Level**

##### **Simple Editing Assistance**

In completing this assessment, you are permitted to use standard editing and referencing functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.

If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.

For more information on Generative AI and permitted use please see [here](#).

When developing R code for your assignment, you are permitted to use Generative AI tools.

Ensure that any assistance received from these tools is fully acknowledged with proper referencing.

## Examination

### Assessment Overview

The examination will aim to assess the achievement of the learning course outcomes.

### Course Learning Outcomes

- CLO1 : Define key principles of actuarial modeling.
- CLO2 : Explain terminologies and classifications of stochastic processes.
- CLO3 : Identify features and properties of Markov Chains.
- CLO4 : Apply Markov Chains to frequency-based NCD schemes using data.
- CLO5 : Describe and utilize Markov Processes in insurance and financial models.
- CLO6 : Evaluate Markov processes in financial and insurance modeling.
- CLO7 : Implement Monte Carlo simulations for stochastic processes.
- CLO8 : Use Monte Carlo simulations in simple actuarial problems.
- CLO9 : Estimate transition probability and matrix of discrete-time and continuous-time Markov chains.
- CLO10 : Discuss actuarial models with an understanding of their ethical implications.
- CLO11 : Present complex actuarial models effectively in written form.
- CLO12 : Produce professionally structured reports based on actuarial modelling.

### Detailed Assessment Description

The final examination will assess students' understanding of the concepts covered in the course and readings and their ability to apply them to practical problems. A deeper grasp of materials is expected from students at the final exam level. The final exam will be an invigilated closed book exam held on UNSW's Kensington campus on a date scheduled by the university, and it will last for 2 hours. It is a mandatory requirement that you attend the exam on campus. All calculators must be UNSW approved. The University will not supply calculators to students for use in examinations. It is the student's responsibility to be familiar with the rules governing the conduct of examinations. Further instructions on how to prepare for the exam will be provided to you during the term.

### Assessment Length

2 hours

### Assignment submission Turnitin type

This is not a Turnitin assignment

## Generative AI Permission Level

### No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.

For more information on Generative AI and permitted use please see [here](#).

## General Assessment Information

As a student at UNSW you are expected to display [academic integrity](#) in your work and interactions. Where a student breaches the [UNSW Code of Conduct](#) with respect to academic integrity, the University may take disciplinary action. To assure academic integrity, you may be required to demonstrate reasoning, research and the process of constructing work submitted for assessment.

To assist you in understanding what academic integrity means, and how to ensure that you do comply with the UNSW Code of Conduct, it is strongly recommended that you complete the [Working with Academic Integrity](#) module before submitting your first assessment task. It is a free, online self-paced Moodle module that should take about one hour to complete.

### Grading Basis

Standard

### Requirements to pass course

In order to pass the course students must obtain an overall composite mark of at least 50 out of 100. It is important that students be punctual and reliable when submitting assessment items. This is an important workplace requirement and students need to ensure they meet deadlines. Your regular and punctual attendance at lectures and tutorials is expected in this course.

# Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 9 September - 15 September	Lecture	Module 0: Stochastic processes Module 1: Discrete-time Markov Chains
Week 2 : 16 September - 22 September	Lecture	Module 1: Discrete-time Markov Chains Module 2: Introduction to Simulation
Week 3 : 23 September - 29 September	Lecture	Module 2: Introduction to Simulation Module 3: Exponential Distribution and the Poisson Process
Week 4 : 30 September - 6 October	Lecture	Module 3: Exponential Distribution and the Poisson Process
Week 5 : 7 October - 13 October	Lecture	Module 4: Continuous-time Markov Chains
	Assessment	Formative assessment (Online quiz 1)
Week 6 : 14 October - 20 October	Other	No classes in flexibility week
Week 7 : 21 October - 27 October	Lecture	Module 4: Continuous-time Markov Chains
Week 8 : 28 October - 3 November	Lecture	Module 4: Continuous-time Markov Chains
Week 9 : 4 November - 10 November	Lecture	Module 5: Estimating Markov Chain transition probabilities and matrices
	Assessment	Assignment due
Week 10 : 11 November - 17 November	Lecture	Module 5: Estimating Markov Chain transition probabilities and matrices
	Assessment	Formative assessment (Online quiz 2)

## Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

## General Schedule Information

The timetable may be altered. Students will be advised of any changes in lectures and via the course web site.

## Course Resources

### Prescribed Resources

The prescribed textbook is

- Sheldon M. Ross, *Introduction to Probability Models*, 13th edition, Academic Press, 2023

It is strongly recommended that students get a copy.

Print: <https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9780443187612>

Digital: <https://unswbookshop.vitalsource.com/products/-v9780443187605>

# Recommended Resources

- Sheldon M. Ross, Stochastic Processes, 2nd edition, John Wiley, 1996

## Course Evaluation and Development

Each year feedback is sought from students and other stakeholders about the courses offered in the School and continual improvements are made based on this feedback. UNSW's myExperience survey is one of the ways in which student evaluative feedback is gathered. In this course, we will seek your feedback through end of semester myExperience responses.

## Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	Eric Cheung					No	Yes

## Other Useful Information

### Academic Information

#### COURSE POLICIES AND SUPPORT

The Business School expects that you are familiar with the contents of this course outline and the UNSW and Business School learning expectations, rules, policies and support services as listed below:

- Program Learning Outcomes
- Academic Integrity and Plagiarism
- Student Responsibilities and Conduct
- Special Consideration
- Protocol for Viewing Final Exam Scripts
- Student Learning Support Services

Further information is provided on the [Policies and Guidelines](#) page.

Students may not circulate or post online any course materials such as handouts, exams, syllabi or similar resources from their courses without the written permission of their instructor.

### STUDENT LEARNING OUTCOMES

The Course Learning Outcomes (CLOs) – under the Outcomes tab – are what you should be able to demonstrate by the end of this course, if you participate fully in learning activities and successfully complete the assessment items.

CLOs also contribute to your achievement of the Program Learning Outcomes (PLOs), which are developed across the duration of a program. PLOs are, in turn, directly linked to [UNSW graduate capabilities](#). More information on Coursework PLOs is available on the [Policies and Guidelines](#) page. For PG Research PLOs, including MPDBS, please refer to [UNSW HDR learning outcomes](#).

## Academic Honesty and Plagiarism

As a student at UNSW you are expected to display [academic integrity](#) in your work and interactions. Where a student breaches the [UNSW Code of Conduct](#) with respect to academic integrity, the University may take disciplinary action. To assure academic integrity, you may be required to demonstrate reasoning, research and the process of constructing work submitted for assessment.

To assist you in understanding what academic integrity means, and how to ensure that you do comply with the UNSW Code of Conduct, it is strongly recommended that you complete the [Working with Academic Integrity](#) module before submitting your first assessment task. It is a free, online self-paced Moodle module that should take about one hour to complete.

## Submission of Assessment Tasks

### SHORT EXTENSIONS

Short Extension is a new process that allows you to apply for an extended deadline on your assessment without the need to provide supporting documentation, offering immediate approval during brief, life-disrupting events. Requests are automatically approved once submitted.

Short extensions are ONLY available for some assessments. Check your course outline or Moodle to see if this is offered for your assessments. Where a short extension exists, all students enrolled in that course in that term are eligible to apply. Further details are available the [UNSW Current Students](#) page.

### SPECIAL CONSIDERATION

You can apply for special consideration when illness or other circumstances beyond your control interfere with your performance in a specific assessment task or tasks, including online exams. Special consideration is primarily intended to provide you with an extra opportunity to demonstrate the level of performance of which you are capable.

Applications can only be made online and will NOT be accepted by teaching staff. Applications will be assessed centrally by the Case Review Team, who will update the online application with the outcome and add any relevant comments. The change to the status of the application immediately sends an email to the student and to the assessor with the outcome of the application. The majority of applications will be processed within 3-5 working days.

For further information, and to apply, see Special Consideration on the UNSW [Current Students](#) page.

## LATE SUBMISSION PENALTIES

### LATE SUBMISSION PENALTIES

For assessments other than examinations, late submission will incur a penalty of 5% per day or part thereof (including weekends) from the due date and time. An assessment will not be accepted after 5 days (120 hours) of the original deadline unless special consideration has been approved. In the case of an approved Equitable Learning Plan (ELP) provision, special consideration or short extension, the late penalty applies from the date of approved time extension. After five days from the extended deadline, the assessment cannot be submitted.

An assessment is considered late if the requested format, such as hard copy or electronic copy, has not been submitted on time or where the 'wrong' assessment has been submitted.

For assessments which account for 10% or less of the overall course grade, and where answers are immediately discussed or debriefed, the LIC may stipulate a different penalty. Details of such late penalties will be available on the course Moodle page.

## FEEDBACK ON YOUR ASSESSMENT TASK PERFORMANCE

Feedback on student performance from formative and summative assessment tasks will be provided to students in a timely manner. Assessment tasks completed within the teaching period of a course, other than a final assessment, will be assessed and students provided with feedback, with or without a provisional result, within 10 working days of submission, under

normal circumstances. Feedback on continuous assessment tasks (e.g. laboratory and studio-based, workplace-based, weekly quizzes) will be provided prior to the midpoint of the course.

## Faculty-specific Information

### PROTOCOL FOR VIEWING FINAL EXAM SCRIPTS

UNSW students have the right to view their final exam scripts, subject to a small number of very specific exemptions. The UNSW Business School has set a [protocol](#) under which students may view their final exam script. Individual schools within the Faculty may also set up additional local processes for viewing final exam scripts, so it is important that you check with your School.

If you are completing courses from the following schools, please note the additional school-specific information:

- Students in the **School of Accounting, Auditing & Taxation** who wish to view their final examination script should also refer to [this page](#).
- Students in the **School of Banking & Finance** should also refer to [this page](#).
- Students in the **School of Information Systems & Technology Management** should also refer to [this page](#).

### COURSE EVALUATION AND DEVELOPMENT

Feedback is regularly sought from students and continual improvements are made based on this feedback. At the end of this course, you will be asked to complete the [myExperience survey](#), which provides a key source of student evaluative feedback. Your input into this quality enhancement process is extremely valuable in assisting us to meet the needs of our students and provide an effective and enriching learning experience. The results of all surveys are carefully considered and do lead to action towards enhancing educational quality.

### QUALITY ASSURANCE

The Business School is actively monitoring student learning and quality of the student experience in all its programs. A random selection of completed assessment tasks may be used for quality assurance, such as to determine the extent to which program learning goals are being achieved. The information is required for accreditation purposes, and aggregated findings will be used to inform changes aimed at improving the quality of Business School programs. All material used for such processes will be treated as confidential.

### TEACHING TIMES AND LOCATIONS

Please note that teaching times and locations are subject to change. Students are strongly advised to refer to the [Class Timetable website](#) for the most up-to-date teaching times and locations.