Australian School of Business
Actuarial Studies

ACTL5103
STOCHASTIC MODELLING FOR ACTUARIES

COURSE OUTLINE
SESSION 2, 2009

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Sydney 2052 Australia

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Dear Students

Welcome to ACTL5103 Stochastic Modelling for Actuaries. This course is one of eight courses covering the Core Technical subjects of the Institute of Actuaries offered in the Master of Actuarial Studies. Many of you will also be completing the courses ACTL5106 Insurance Risk Models and/or ACTL5109 Financial Economics for Insurance and Superannuation in this session. ACTL5103 is closely linked to these courses. In the early weeks of the courses you should take some time to note the links between these courses.

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. We hope that you will find the course challenging and interesting.

In this course outline, you will find the details of the course requirements, course aims and learning outcomes, content, teaching methods, assessment tasks, texts and readings, and expectations. Please read it carefully and thoroughly, as it will be assumed that you are familiar with the contents.

If you have any questions about the course then please contact me.

I look forward to guiding your learning through the duration of the course.

Jinxia Zhu
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1. **STAFF CONTACT DETAILS**

The Course Coordinator and Lecturer of this course is:

<table>
<thead>
<tr>
<th>Staff</th>
<th>E-mail</th>
<th>Room</th>
<th>Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Jinxia Zhu</td>
<td><a href="mailto:jinxia.zhu@unsw.edu.au">jinxia.zhu@unsw.edu.au</a></td>
<td>Quad 2073</td>
<td>9385 7385</td>
</tr>
</tbody>
</table>

Dr. Zhu is responsible for the administration and final assessment of the course, as well as the lectures and related teaching and learning.

1.1 **Communication with Staff**

Jinxia will normally be available for consultation on Thursdays during teaching session from 3:00pm to 5:00pm in Quad 2073. For other times, appointments should normally be made in advance.

If students have questions about the material covered in lectures then consult the Course Lecturer. For tutorial problems or other problems with assignments and course material students should consult the tutor. For administrative matters related to the course including enrolment, tutorial enrolment, assessment, special consideration, and the course web site, students should consult the Course Coordinator or the School Administrator (Bindya Subba).

All non-academic queries should be addressed to:

Bindya Subba  
Actuarial Studies Office  
Room 2058, Quadrangle Building  
Telephone: 9385 1886  
Fax: 9385 1883  
E-mail: b.subba@unsw.edu.au

2. **COURSE DETAILS**

2.1 **Teaching times and Locations**

**Lectures**  
This course will consist of 3 hours of lectures and 1 hour of tutorial per week.

Lecture times and locations are as follows:

Thursday 18:00 – 21:00  
ASB 205

Timetables and locations are correct at time of printing. A full timetable of lectures and topics is provided later in this Course study guide. Any alterations to the lecture times or locations will be advised in lectures and via the Course WebCT Vista site.

Students should consult the WebCT Vista site on a regular basis, since assignment questions and other Course materials will be placed there. The web address is:  
http://vista.elearning.unsw.edu.au.

2.2 **Units of Credit**  
6
2.3 Parallel teaching in the course
Although the courses cover very similar material, ACTL3001 and ACTL5104 are taught separately. Students enrolled in ACTL3001 must attend the undergraduate lectures. Students attending ACTL5104 must be enrolled in the Master of Actuarial Studies. Faculty and School policy does not allow undergraduate attendance at postgraduate lectures.

2.4 Summary of Course
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. Topics covered include main features of a Markov chain and applications to experience rating; Markov process models and applications to insurance, survival, sickness and marriage models; simple time series models including random walk and auto-regressive models and their application to investment variables; properties of Brownian motion and applications to investment variables; methods for simulation of a stochastic process. Students will be expected to implement models using spreadsheets or programs in a numerical computer package.

It contributes to the actuarial professional subjects CT4 Models & CT6 Statistical Models of the Institute of Actuaries. CT4 exemption is determined by the average of ACTL5103 and ACTL5104 marks. CT6 exemption is determined by the average of ACTL5103 and ACTL5106 marks. This average will have to be 65% or higher in order to be recommended for exemptions.

2.5 Course Aims and Relationship to other courses
The primary aim of this course is to provide students with an understanding of the mathematical concepts and techniques that are used by actuaries to model stochastic processes of both assets and liabilities. The aims of this course are to help students develop:

1. A capability to implement Markov Chains for a frequency-based experience rating No Claim Discount (NCD) scheme using data.
2. An understanding of Markov processes that can be used for insurance, survival, sickness and financial modelling.
3. An understanding of Poisson processes that can be used for insurance, credit and operational risk management.
4. An understanding of Gauss-Wiener processes that can be used for asset and financial derivatives pricing and interest rate modelling.
5. Develop an understanding of the basic concepts underlying the analysis of time series model and a capability to apply basic concepts to data.
6. Develop an understanding of the main concepts of ‘Monte Carlo’ simulation of a stochastic process and a capability to carry out simple simulation procedures.

Students are assumed to have knowledge of probability and statistics to the level covered in the course ACTL5101 Probability and Statistics for Actuaries (or equivalent courses in the School of Mathematics). They should also be proficient with calculus and linear algebra. Students need to be able to use a computer to analyse mathematical and statistical problems.
You should be familiar with a word processing package (such as WORD), a spreadsheet (such as EXCEL) and a statistical package (such as R). Students should use the computer programs they are most familiar with in doing assignments and other assigned tasks. The R software is considered by many statisticians and researchers to be a very versatile statistical package, and is an open-source software which is freely downloadable from the R-project website (http://www.r-project.org).

2.6 Student Learning Outcomes (includes objectives of the Institute of Actuaries Subject CT4 and CT6)
At the end of this course students should be able to:

1. Describe and explain the principles of actuarial modelling.

2. Describe and explain the main terminology of stochastic processes, including their classification into different types.

3. Define the key features and properties of a Markov Chain and use a Markov Chain to analyse insurance applications including a frequency based experience rating No Claim Discount (NCD) scheme.

4. Define the main features of a Markov Process and use simple Markov Processes to analyse insurance, survival, sickness and marriage models.

5. Define the main concepts underlying the analysis of time series models including simple non-stationary models and apply these models to actuarial models for investment returns and inflation.

6. Define and apply the main concepts of Gauss-Wiener processes.

7. Explain the concepts of 'Monte Carlo' simulation of a stochastic process using a series of pseudo-random numbers and apply simulation to simple actuarial problems.

8. Use the software package R to analyse mathematical or statistical problems.

And should have

9. Developed communication skills for the presentation of complex statistical models in written report form.

Graduate Attributes
This course contributes to your development of the following Australian School of Business Graduate Attributes, which are the qualities, skills and understanding we want you to have by the completion of your degree. Learning Outcomes 1–8 aim to enhance your capacity for critical thinking and problem solving (Graduate Attribute 1). Learning Outcome 9 aims to develop your written communication skills (Graduate Attribute 2). All Learning Outcomes 1–9 aim to develop your in-depth engagement with relevant disciplinary knowledge (Graduate Attribute 5). Success in the course is indicative of development of ASB Graduate Attribute 6, professional skills (particularly those of task and time management).
3. LEARNING AND TEACHING ACTIVITIES

3.1 Approach to Learning and Teaching in the Course
The course textbooks, lectures and assessment tasks are designed to provide a framework for your learning. Every student has a different approach to learning. How much time you spend on reading in preparation for lectures, completing assessment tasks, reviewing course objectives, deepening your understanding and preparing for final examinations will depend on your learning approach. Lectures will generally cover the main concepts and issues and will not necessarily cover all the details of the course readings or texts. It is expected that you have read the reading material for the lecture in advance. Students who are successful in this course take an active approach to learning.

3.2 Learning Activities and Teaching Strategies
The course involves three key components – the lecture, the tutorial and your private study.

Each lecture will provide a short overview of topic at hand and will then focus on explaining the difficult concepts and issues. The role of the lecture is to help you understand the context of the topic as well as work through the difficult points. Students will need to read the prescribed readings prior to the lecture.

Each tutorial will involve a number of exercises that relate to the current week’s topic. You are required to prepare for each tutorial and the tutorial will require your participation. The exercises to be covered in each tutorial are available on WebCT. The role of the tutorial is to help build your understanding of the topic through the application of what you have learnt to a variety of different problems. They also give you the opportunity to discuss your work with your colleagues, and hence gain an indication of your own progress. Tutorials also foster development of ASB Graduate Attributes 1, 2 and 5.

Your private study is the most important component of this course. Weekly readings, tutorial exercises, solving problems from the text and your own topic summaries form the basis of an excellent private study regime. Keeping up to date is very important and each week builds on the prior weeks so it is important that you get your study regime organised quickly. In these ways, your self-study develops ASB Graduate Attributes 1, 5 and 6.

4. ASSESSMENT

4.1 Formal Requirements
In order to pass the course students must complete and submit all components of assessment on or before the due date. Late assessment submissions will not be marked. It is important that students be punctual and reliable when submitting assessments. This is an important workplace requirement and students need to ensure they meet deadlines.
4.2 Assessment Details

The following table gives the relative weighting of the assessment components:

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Weighting</th>
<th>Learning Outcomes Assessed</th>
<th>ASB Graduate Attributes assessed</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Class Test 1</td>
<td>7.5%</td>
<td>1,2,3,4,5,6,7</td>
<td>1,2,5,6</td>
<td>Week 4 Thursday 13 Aug 18:05</td>
</tr>
<tr>
<td>2. Class Test 2</td>
<td>7.5%</td>
<td>1,2,3,4,5,6,7</td>
<td>1,2,5,6</td>
<td>Week 8 Thursday 17 Sep 18:05</td>
</tr>
<tr>
<td>3. Assignment</td>
<td>10%</td>
<td>1,2,3,4,5,6,7,8,9</td>
<td>1,2,5,6</td>
<td>Week 11 Thursday 8 Oct 17:55</td>
</tr>
<tr>
<td>4. Final Examination</td>
<td>75%</td>
<td>1,2,3,4,5,6,7</td>
<td>1,2,5,6</td>
<td>TBA</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Class Tests

Technical skills are important in practice and this course provides foundation technical skills that will be useful throughout your working life.

In order to assess your understanding of the technical skills covered in the course aims there will be two class tests during the session. The class tests will be administered during lectures. Each class test will be worth 7.5% of the total assessment for the course. The class tests will be closed book. Students will only be allowed to bring the text "Formulae and Tables for Actuarial Examinations" into the class tests.

Normal examination rules apply to the conduct of class tests. Calculators will be allowed in the class tests and the final examination but a clear indication of all of the steps involved in your calculations must be shown. The University will not supply calculators to students for use in examinations where the provision of calculators has not been requested by the course examiner. It is the student’s responsibility to be familiar with the rules governing the conduct of examinations.

Class tests will be held in the lecture theatre at the scheduled lecture time:

**Class Test 1**  Thursday 13 Aug 18:05  
**Class Test 2**  Thursday 17 Sep 18:05

Assignment

The practical application of the course concepts based on actual data from insurance and financial markets 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.

There will be one major Assignment for this course involving the practical application of course concepts to an actuarial problem. This will provide students with an opportunity to also develop writing skills.
The assignment you submit must be your own work. Students who copy other student’s assignment solutions will be penalised. The assignments will be assessed on both technical accuracy, practical application and how well it is written and the quality of the assignment presentation.

The assignment must be submitted in the assignment box provided outside Quad 2059, Level 2 Quadrangle Building, near the Actuarial Studies office. Due date is

**Thursday 8 Oct 17:55 am**

**Final Examination**
The final examination will assess students’ understanding of the concepts covered in the course and their ability to apply them to probability and statistics problems.

The final examination will be a three-hour written paper. The final examination will be closed book. Students will only be allowed to bring the text "Formulae and Tables for Actuarial Examinations" into the exam.

**4.3 Assignment Format**
Just as solving the assignment problems is a challenging experience for students, marking the assignment solutions is a challenging experience for staff. In order for us to give you the maximum credit for your efforts, we ask that you abide by the following formatting requirements:

- Number all pages. The first page of your assignment must be the (signed) Actuarial Studies assignment cover sheet.
- Secure the pages of your assignment with a staple (or staples) only in the top left hand corner. Do not submit your assignment in a folder of any sort. Questions should be bound together in ascending order.
- For analytic questions involving no computer resources, neatly write up or type your response and reasoning as clearly as you can.
- For analytic questions requiring you to resort to computer software, use the following example as a guide. Say question 4 of the assignment asks you to calculate the average of a group of numbers appearing in a given dataset, and you went away and wrote thirty different computer programs in five different programming languages to do this which operate on all major operating systems currently in use, and also some that were in vogue in the 1960s. We require that in the main body of your assignment (the ‘front’), you answer Question 4 with some text (akin to ‘Average is 2’). You should then briefly point out the method you used to achieve this result, and then direct the marker to appendix C (or other) of your assignment (the ‘back’) where you have carefully detailed and labelled the relevant code and output.
- For written answer questions, like the article review, please type and double space your response. Do not type on both sides of a single page. Cite any sources you use using the Harvard System and include all cited sources in a bibliography at the end of the question. Use an adequate margin on both the left and right hand sides of the page. In general, all quotations should be enclosed with single inverted commas. The exception is quotations of two or more sentences that run to four or more lines—these quotes should be indented. However, long quotes should be avoided where possible.

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1 Spiral-bound assignments are acceptable if the assignment, when opened at any double-page layout and simply folded back (so the first and last pages of the assignment are now adjacent, and folded with a minimum of physical exertion), lies flat and there is scant possibility of the pages turning.
4.4 Assignment Submission Procedure
Assignments must be placed in the box provided outside Quad 2059, Level 2 Quadrangle Building, near the Actuarial Studies office. A cover sheet must accompany these assignments. A copy of the cover sheet is available from the course WebCT site. Additional copies of the cover sheet can be obtained outside Quad 2059. Please note that it is School policy that late assignments will not be marked.

4.5 Late Submission
The School of Actuarial Studies has a policy of grading late assignments with a zero mark. Punctual submission of work is required in order to satisfy the requirements of the course. The assignment may be marked at the discretion of the course co-ordinator if there is a valid reason for late submission and used in cases where your final overall results are marginal.

5 ACADEMIC HONESTY AND PLAGIARISM
The University regards plagiarism as a form of academic misconduct, and has very strict rules regarding plagiarism. For UNSW policies, penalties and information to help you avoid plagiarism see: http://www.lc.unsw.edu.au/plagiarism/index.html as well as the guidelines in the online ELISE tutorial for all new UNSW students: http://info.library.unsw.edu.au/skills/tutorials/InfoSkills/index.htm.

To see if you understand plagiarism, do this short quiz:
http://www.lc.unsw.edu.au/plagiarism/plagquiz.html

For information on how to acknowledge your sources and reference correctly, see:
http://www.lc.unsw.edu.au/onlib/ref.html

For the ASB Harvard Referencing Guide, see:

School of Actuarial Studies Policy on Plagiarism
The School of Actuarial Studies views any form of plagiarism as unacceptable. The School follows University Procedures in the event of any student plagiarism. In cases of plagiarism for in session assessment the minimum penalty all students involved can expect is to receive a mark of zero for the particular assessment item. The Head of School will be informed, and the School will also keep a record of student Plagiarism cases. Students should familiarise themselves with the University Policy and Procedures and ensure they have consulted The Learning Centre web site so that they are aware of and understand the concepts and practices of academic honesty and plagiarism.

6 COURSE RESOURCES
Textbooks
The textbooks for the course are:


Formulae and Tables for Actuarial Examinations of the Faculty of Actuaries and the Institute of Actuaries.
Other References
The following references also provide a detailed and comprehensive coverage of the topics covered in the Course.

The Actuarial Education Company (ActEd), CT4 and CT6 Course Notes – only the relevant sections related to ACTL5103 course which are Chapters 1 to 6 inclusive of CT4 and Chapters 12 to 14 inclusive of CT6.

Some topics in the course are also covered in the following textbooks and the students may find the following references also helpful reading materials:


Software
To complete the assignment of this course, students may need to use the statistical language R. R is a freely available at http://www.r-project.org. For useful background for the R software package:


Formulae & Tables
Students will only be allowed to bring into the examinations for the Actuarial courses in the BCom the text "Formulae and Tables for Actuarial Examinations". This text must not be annotated. All students in the actuarial courses should purchase a copy of this text if they wish to use this in the final examinations for this course. The text is available from the UNSW Bookshop, the UK Institute of Actuaries or from ActEd Australia. Visit the ActEd website at http://www.acted.com.au/.

Course WebCT Vista
This course will use WebCT Vista for communication with students. The link therein to ‘The Admin Corner’ (abbreviated as TAC) will prove invaluable.

The WebCT Vista site for this course will contain the course outline, lecture notes, homework and tutorial exercises, assessment information, and any notices relevant to this course. It is important that you visit the site regularly to see any notices posted there by the course coordinator. The site can be accessed from the WebCT Vista log-in page at http://vista.elearning.unsw.edu.au/.

7 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 Course and Teaching Evaluation and Improvement (CATEI) Process is one of the ways in which student evaluative feedback is gathered. Student feedback is taken seriously, and continual improvements are made to the course based on such feedback. Significant changes to the course are communicated to students taking the course. Your input into improving future offerings of the course is highly valued.
8 STUDENT RESPONSIBILITIES AND CONDUCT

Students are expected to be familiar with and adhere to university policies in relation to class attendance and general conduct and behaviour, including maintaining a safe, respectful environment; and to understand their obligations in relation to workload, assessment and keeping informed.


8.1 Workload

It is expected that you will spend at least twelve hours per week studying this course during teaching session. This time should be made up of reading, research, working on exercises and problems, and attending classes. In periods where you need to complete assignments or prepare for examinations, the workload may be greater.

Over-commitment has been a cause of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

8.2 Attendance

Your regular and punctual attendance at lectures and seminars is expected in this course. University regulations indicate that if students attend less than eighty per cent of scheduled classes they may be refused final assessment.

8.3 Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You should seek assistance early if you suffer illness or misadventure which affects your course progress. For advice on UNSW policies and procedures for granting special consideration and supplementary exams, see:


STUDENTS SHOULD NOTE THAT SPECIAL CONSIDERATION WILL NOT BE GRANTED UNLESS PERFORMANCE AND ATTENDANCE AT LECTURES IS SATISFACTORY. THIS WILL USUALLY MEAN THAT YOU WILL HAVE TO PASS ALL ASSESSMENT TASKS IN ORDER FOR ANY SPECIAL CONSIDERATION TO BE GIVEN.
ASB Policy and Process for Special Consideration and Supplementary Exams

In the ASB, requests for special consideration are determined by a Faculty wide panel which will advise the Lecturer in Charge of appropriate action.

If the Faculty panel (see above) grants a special consideration request, this may entitle the student to sit a supplementary examination. In such cases the following procedures will apply:

- Supplementary exams will be scheduled centrally and will be held approximately two weeks after the formal examination period. Actual date will be advised by mid-semester.
- Where a student is granted a supplementary examination as a result of a request for special consideration, the student’s original exam (if completed) will not be marked and only the mark achieved in the supplementary examination will count towards the final grade.

Consideration for Missed Assessments (other than final examination)

If you miss a test or are unable to submit your assignment by the due time & date, and you have a valid reason, you need to inform the Actuarial Studies office as soon as possible. You must provide written documentation requesting consideration to the Actuarial Studies office, in the form of a letter explaining your reasons with evidence attached, i.e. medical certificate, police report etc. You should note the course details, your student ID and contact details in your letter as well. As per University rules these considerations must be submitted within 3 working days of the assessment date. If no request is received or it is received after 3 working days you will be awarded a zero mark for that assessment.

Review of Results of Assessments (other than final examination)

As per University rules, if you wish a piece of course assessment to be re-checked, for addition error or incorrect marking, you need to contact the Actuarial Studies office within 15 working days of the assessment being available for collection. You will need to bring in the assessment and provide a note as to the error or reason for review to the Actuarial Studies office. The assessment will be passed onto the relevant academic for review. Students will be able to collect back the assessment from the Actuarial Studies office.

8.4 General Conduct and Behaviour

You are expected to conduct yourself with consideration and respect for the needs of your fellow students and teaching staff. Conduct which unduly disrupts or interferes with a class, such as ringing or talking on mobile phones, is not acceptable and students may be asked to leave the class. More information on student conduct is available at: www.my.unsw.edu.au

8.5 Occupational Health and Safety

UNSW Policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others. For more information, see https://my.unsw.edu.au/student/atoz/OccupationalHealth.html.
8.6 Keeping Informed
You should take note of all announcements made in lectures, tutorials or on the course web site. From time to time, the University will send important announcements to your university e-mail address without providing you with a paper copy. You will be deemed to have received this information. It is also your responsibility to keep the University informed of all changes to your contact details.

9 ADDITIONAL STUDENT RESOURCES AND SUPPORT
The University and the ASB provide a wide range of support services for students, including:

- **ASB Education Development Unit (EDU)** ([www.business.unsw.edu.au/edu](http://www.business.unsw.edu.au/edu))
  Academic writing, study skills and maths support specifically for ASB students. Services include workshops, online and printed resources, and individual consultations. EDU Office: Room GO7, Ground Floor, ASB Building (opposite Student Centre); Ph: 9385 5584; Email: edu@unsw.edu.au

- **Capturing the Student Voice**: An ASB website enabling students to comment on any aspect of their learning experience in the ASB. To find out more, go to [http://tinyurl.com/ASBStudentVoice](http://tinyurl.com/ASBStudentVoice).

- **UNSW Learning Centre** ([www.lc.unsw.edu.au](http://www.lc.unsw.edu.au))
  Academic skills support services, including workshops and resources, for all UNSW students. See website for details.

- **Library training and search support services**: [http://info.library.unsw.edu.au](http://info.library.unsw.edu.au)

- **UNSW IT Service Desk**: Technical support for problems logging in to websites, downloading documents etc. Library, Level 2; Ph: 9385 1333.
  Website: [www.its.unsw.edu.au/support/support_home.html](http://www.its.unsw.edu.au/support/support_home.html)

- **UNSW Counselling Service** ([http://www.counselling.unsw.edu.au](http://www.counselling.unsw.edu.au))
  Free, confidential service for problems of a personal or academic nature; and workshops on study issues such as ‘Coping with Stress’ and ‘Procrastination’.
  Office: Level 2, Quadrangle East Wing; Ph: 9385 5418

- **Student Equity & Disabilities Unit** ([http://www.studentequity.unsw.edu.au](http://www.studentequity.unsw.edu.au))
  Advice regarding equity and diversity issues, and support for students who have a disability or disadvantage that interferes with their learning.
  Office: Ground Floor, John Goodsell Building; Ph: 9385 4734
## 10 COURSE SCHEDULE

This timetable is tentative and may change. Revisions will be advised as they occur through the course web site.

<table>
<thead>
<tr>
<th>Week No</th>
<th>Week Beginning</th>
<th>Topics Covered</th>
<th>Textbook References*</th>
<th>Assignment, Quiz &amp; Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 July</td>
<td>Introduction to Stochastic Processes Markov Chains</td>
<td>Ross, 9&lt;sup&gt;th&lt;/sup&gt; / 8&lt;sup&gt;th&lt;/sup&gt; Edition, 2.8, 4.1-4.3 CT4, Chap 1 and 2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>27 July</td>
<td>Markov Chains Markov Processes</td>
<td>Ross, 9&lt;sup&gt;th&lt;/sup&gt; /8&lt;sup&gt;th&lt;/sup&gt; Edition, 4.4, 4.5.1, 4.6-4.8, CT4, Chap 3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3 Aug</td>
<td>Exponential Distribution Poisson Process Generalizations of the Poisson Process</td>
<td>Ross, 9&lt;sup&gt;th&lt;/sup&gt; /8&lt;sup&gt;th&lt;/sup&gt; Edition, Chap 5 CT4, Chap 5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10 Aug</td>
<td>Continuous Time Markov Chains</td>
<td>Ross, 9&lt;sup&gt;th&lt;/sup&gt; /8&lt;sup&gt;th&lt;/sup&gt; Edition, 6.1-6.5 CT4, Chap 5</td>
<td>Class Test 1 Thu 13 Aug 18:05</td>
</tr>
<tr>
<td>5</td>
<td>17 Aug</td>
<td>Actuarial applications</td>
<td>CT4, Chap 4,6</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>24 Aug</td>
<td>Simulation</td>
<td>Ross, 9&lt;sup&gt;th&lt;/sup&gt; /8&lt;sup&gt;th&lt;/sup&gt; Edition, 11.1-11.5 CT6, Chap 14</td>
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<tr>
<td>7</td>
<td>31 Aug</td>
<td>Introduction to Time Series</td>
<td>Chan, Chap 1,2 CT6, Chap 12, 13</td>
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<td></td>
<td>7–13 September</td>
<td>Mid-semester break</td>
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<tr>
<td>8</td>
<td>14 Sep</td>
<td>Time Series</td>
<td>Chan, Chap 3 CT6, Chap 12,13</td>
<td>Class Test 2 Thu 17 Sep 18:05</td>
</tr>
<tr>
<td>9</td>
<td>21 Sep</td>
<td>Time Series</td>
<td>Chan, Chap 4 CT6, Chap 12,13</td>
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<td>10</td>
<td>28 Sep</td>
<td>Time Series</td>
<td>Chan, Chap 8 CT6, Chap 12,13</td>
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<tr>
<td>11</td>
<td>5 Oct</td>
<td>Time Series</td>
<td>Chan, Chap 6</td>
<td>Assignment Due Thu 8 Oct 17:55</td>
</tr>
<tr>
<td>12</td>
<td>12 Oct</td>
<td>Brownian Motion</td>
<td>Ross, 9&lt;sup&gt;th&lt;/sup&gt; /8&lt;sup&gt;th&lt;/sup&gt; Edition, 10.1-10.3, 10.5-10.7</td>
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<tr>
<td>13</td>
<td>19 Oct</td>
<td>No lectures</td>
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<td>24 Oct – 29 Oct</td>
<td>Study period</td>
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<td></td>
<td>30 Oct – 17 Nov</td>
<td>Examination period</td>
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</table>
## Lecture Timetable

This timetable may be altered. Any Changes will be advised through the course web site.

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Topics and Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Thursday 23 July</strong>&lt;br&gt;18:00 – 21:00&lt;br&gt;ASB 205</td>
<td><strong>Topics</strong>&lt;br&gt;- Introduction to the course&lt;br&gt;- Principles of actuarial modelling&lt;br&gt;- Introduction to stochastic processes&lt;br&gt;- Introduction to Markov Chains&lt;br&gt;- Chapman-Kolmogorov equations&lt;br&gt;- Classification of states&lt;br&gt;&lt;br&gt;<strong>Readings</strong>&lt;br&gt;Ross, 9th Edition, Chapter 2(2.8), Chapter 4 (4.1-4.3)&lt;br&gt;Ross, 8th Edition, Chapter 2(2.8), Chapter 4 (4.1-4.3)&lt;br&gt;&lt;br&gt;<strong>Reference</strong>&lt;br&gt;ACTED Chapter 1 and 2 CT4</td>
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<td>2</td>
<td><strong>Thursday 30 July</strong>&lt;br&gt;18:00 – 21:00&lt;br&gt;ASB 205</td>
<td><strong>Topics</strong>&lt;br&gt;- Limiting Probabilities&lt;br&gt;- Mean time in transient states&lt;br&gt;- Gambler’s ruin&lt;br&gt;- Branching processes&lt;br&gt;- Time reversible Markov chains&lt;br&gt;&lt;br&gt;<strong>Readings</strong>&lt;br&gt;Ross, 9th Edition, Chapter 4 (4.4, 4.5.1, 4.6-4.8)&lt;br&gt;Ross, 8th Edition, Chapter 4 (4.4, 4.5.1, 4.6-4.8)&lt;br&gt;&lt;br&gt;<strong>Reference</strong>&lt;br&gt;ACTED Chapter 3 CT4</td>
</tr>
<tr>
<td>3</td>
<td><strong>Thursday 6 August</strong>&lt;br&gt;18:00 – 21:00&lt;br&gt;ASB 205</td>
<td><strong>Topics</strong>&lt;br&gt;- Exponential distribution&lt;br&gt;- Poisson process&lt;br&gt;- Generalizations of the Poisson process&lt;br&gt;&lt;br&gt;<strong>Readings</strong>&lt;br&gt;Ross, 9th Edition, Chapter 5&lt;br&gt;Ross, 8th Edition, Chapter 5&lt;br&gt;&lt;br&gt;<strong>Reference</strong>&lt;br&gt;ACTED Chapter 5 CT4</td>
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<td>Week</td>
<td>Lecture</td>
<td>Topics and Readings</td>
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</table>
| 4    | Thursday 13 August 18:00 – 21:00 ASB 205 | Class Test 1 (Thursday 13 August, 18:05-19:00)  
Topics  
- Continuous-Time Markov Chains  
- Birth and death processes  
- Transition probabilities  
- Kolmogorov equations  
- Limiting probabilities  
Readings  
Ross, 9th Edition, Chapter 6 (6.1-6.5)  
Ross, 8th Edition, Chapter 6 (6.1-6.5)  
Reference  
ACTED Chapter 5 CT4 |
| 5    | Thursday 20 August 18:00 – 21:00 ASB 205 | Topics  
- Actuarial applications  
- Mortality and sickness models  
Reference  
ACTED Chapter 4 and 6 CT4 |
| 6    | Thursday 27 August 18:00 – 21:00 ASB 205 | Topics  
- Introduction to Simulation  
- Generating continuous random variables  
- Simulating discrete random variables  
- Stochastic Process Simulation  
- Multivariate normal  
- Variance Reduction Techniques  
- Number of runs  
Readings  
Ross, 9th Edition, Chapter 11 (11.1-11.5)  
Ross, 8th Edition, Chapter 11 (11.1-11.5)  
Reference  
ACTED Chapter 14 CT6 |
<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Topics and Readings</th>
</tr>
</thead>
</table>
| 7    | Thursday 3 September 18:00 – 21:00 ASB 205 | **Topics**  
  - Introduction to time series  
  - Properties of a univariate time series  
  - Trends, seasonal cycles, transformation  
  - Sample correlation functions  
  - Moving Average (MA) models  
  **Readings**  
  Chan, Chapters 1, 2  
  **Reference**  
  ACTED Chapter 12 and 13 CT6  |
| 8    | Thursday 17 September 18:00 – 21:00 ASB 205 | **Class Test 2**  
  *(Thursday 17 September, 18:05-19:00)*  
  **Topics**  
  - Autoregressive (AR) models  
  - ARMA models  
  - ARIMA models  
  **Readings**  
  Chan, Chapter 3  
  **Reference**  
  ACTED Chapter 12 and 13 CT6  |
| 9    | Thursday 24 September 18:00 – 21:00 ASB 205 | **Topics**  
  - Model parameter estimations  
  - Partial ACF  
  - Order selections  
  - Residual analysis  
  - Model building  
  **Readings**  
  Chan, Chapter 4  
  **Reference**  
  ACTED Chapter 12 and 13 CT6  |
<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Topics and Readings</th>
</tr>
</thead>
</table>
| 10   | Thursday 1 October 18:00 – 21:00 ASB 205 | **Topics**  
  - Nonstationarity  
  - Unit root test  
  - Simulations  

**Readings**  
Chan, Chapter 8  

**Reference**  
ACTED Chapter 12 and 13 CT6 |
| 11   | Thursday 8 October 18:00 – 21:00 ASB 205 | **Assignment Due**  
(Thursday 8 October, 17:55)  

**Topics**  
- Introduction to forecasting  
- Simple forecasts  
- Box-Jenkins approach  

**Readings**  
Chan, Chapter 6 |
| 12   | Thursday 15 October 18:00 – 21:00 ASB 205 | **Topics**  
  - Introduction to Brownian motion  
  - Brownian motion with drift  
  - Geometric Brownian motion  
  - White noise  
  - SDEs and Ito formula  

**Readings**  
Ross, 9th Edition, Chapter 10 (10.1-10.3, 10.5-10.7)  
Ross, 8th Edition, Chapter 10 (10.1-10.3, 10.5-10.7) |