ACTL5103
Stochastic Modelling for Actuaries

Course Outline
Semester 2, 2015

Part A: Course-Specific Information

Please consult Part B for key information on Business School policies (including those on plagiarism and special consideration), student responsibilities and student support services.
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PART A: COURSE-SPECIFIC INFORMATION

1 STAFF CONTACT DETAILS
Lecturer-in-charge: Jonathan Ziveyi
Room Business School Building, Room 648
Phone No: 9385 8006
Email: j.ziveyi@unsw.edu.au
Consultation Times – Tuesdays 12pm – 1pm (or by appointment)

Who should I contact?

- Administrative enquiries about the course and questions about the lectures, tutorial problems and assessment items: Jonathan Ziveyi.
- Enquiries about postgraduate coursework programs in Actuarial Studies: the School of Risk & Actuarial Studies office (rasadmin@unsw.edu.au).
- Enrolment: Business School Student Centre.

2 COURSE DETAILS

2.1 Teaching Times and Locations
This course consists of three hours of lectures and one hour tutorial per week.

Lectures start in Week 1 (to Week 12). The time and location are:

Wednesdays 6pm - 9pm in the Law Theatre G23 (K-F8-G23)

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 Website.

Students should consult Course Website on a regular basis, since assignment questions and other course materials will be placed there.

2.2 Units of Credit
The course is worth 6 units of credit.

2.3 Summary of Course
This course provides an introduction to the stochastic models used by actuaries to model both liabilities and assets illustrating 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.

2.4 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:

A. An understanding of Markov Chains and capability to implement for a frequency-based experience rating No Claim Discount (NCD) scheme using data.
B. An understanding of Markov processes that can be used for insurance, survival, sickness, financial modelling, credit and operational risk management.
C. Develop an understanding of the main concepts of “Monte Carlo” simulation of a stochastic process and a capability to carry out simple simulation procedures.
D. Develop an understanding of the basic concepts underlying the analysis of time series model and a capability to apply basic concepts to data.
E. Express your views on, and understanding of, an aspect of stochastic modelling.

This course provides an introduction to the stochastic models used by actuaries to model both assets and liabilities illustrating their applications in actuarial work. The material is at a mathematically rigorous level with a strong foundation in mathematics. The required knowledge of the course is a good understanding of probability and statistics as covered in ACTL5101 Probability and Statistics for Actuaries. They 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. Consult the Course Coordinator if you do not have the required mathematical background.

ACTL5103 builds on the basic concepts of probability and statistics covered in ACTL5101 Actuarial Studies and Commerce. The course will have applications in other courses in the actuarial major. More advanced models are covered in ACTL5104 Actuarial Statistics and ACTL5106 Insurance Risk Models. The course is necessary for the more advanced coverage in ACTL5104 Actuarial Statistics, ACTL5105 Life Insurance and Superannuation Models, ACTL5106 Insurance Risk Models, and ACTL5109 Financial Economics for Insurance and Superannuation.

The course contributes to the actuarial professional subjects CT4 Models & CT6 Statistical Models of the Institute of Actuaries. Students achieving an average of 65% or higher of ACTL5103 (1/3 of grade) and ACTL5104 (2/3 of grade) marks will be recommended for exemption from the professional CT4 examination. Students achieving an average of 65% or higher of ACTL5103 (1/3 of grade) and ACTL5106 (2/3 of grade) marks will be recommended for exemption from the professional CT6 examination. Exemptions from professional actuarial examinations require above average performance in the equivalent University course.

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 or MATLAB). Students should use the computer programs they are most familiar with in doing assignments and other assigned tasks. Use of one of the matrix based computer program such as Maple, Matlab (http://www.mathworks.com/products/matlab/) or Octave http://www.gnu.org/software/octave/ may assist in completing assignment tasks. The R software is also 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).
2.5 Student Learning Outcomes

The aims of Section 2.4 (A to E) have been broken down into the following learning outcomes. At the end of the course students should be able to:

A1. Describe and explain concepts and principles of actuarial modelling.
A2. Describe and explain the main terminology of stochastic processes, including their classification into different types.
A3. Define the key features and properties of a Markov Chain
A4. Developed a capability to implement Markov Chains for a frequency-based experience rating No Claim Discount (NCD) scheme using data.
B1. Define the main features of a Markov Process and use simple Markov Processes to analyse insurance, survival, sickness and marriage models.
B2. Developed an understanding of Markov processes that can be used for insurance, survival, sickness and financial modelling.
B3. Developed an understanding of Poisson processes that can be used for insurance, credit and operational risk management
C1. Developed an understanding of the main concepts of “Monte Carlo” simulation of a stochastic process and a capability to carry out simple simulation procedures.
C2. 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.
D1. Define the main concepts underlying the analysis of time series models including simple nonstationary models
D2. Application of time series models to actuarial models for investment returns and inflation.
E1 Express your views on, and understanding of, an aspect of statistical models.
E2 Develop communication skills for the presentation of complex statistical models in written report form.

This course corresponds largely with the actuarial professional subjects CT4 Models and CT6 Statistical Methods.

The course’s Learning Outcomes relate to the aims of this Institute of Actuaries course in the following way:

<table>
<thead>
<tr>
<th>Course Learning Outcomes</th>
<th>Institute of Actuaries aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>CT4: (i)</td>
</tr>
<tr>
<td>A2</td>
<td>CT4: (ii)</td>
</tr>
<tr>
<td>A3</td>
<td>CT4: (iii)</td>
</tr>
<tr>
<td>A4</td>
<td>CT4: (iii)</td>
</tr>
<tr>
<td>B1</td>
<td>CT4: (iv)</td>
</tr>
<tr>
<td>B2</td>
<td>CT4: (iv)</td>
</tr>
<tr>
<td>B3</td>
<td>CT4: (iv)</td>
</tr>
<tr>
<td>C1</td>
<td>CT6: (ix)</td>
</tr>
</tbody>
</table>
The Course Learning Outcomes are what you should be able to DO by the end of this course if you participate fully in learning activities and successfully complete the assessment items.

The Learning Outcomes in this course also help you to achieve some of the overall Program Learning Goals and Outcomes for all postgraduate coursework students in the Business School. Program Learning Goals are what we want you to BE or HAVE by the time you successfully complete your degree (e.g. “be an effective team player”). You demonstrate this by achieving specific Program Learning Outcomes - what you are able to DO by the end of your degree (e.g. “participate collaboratively and responsibly in teams”).

For more information on the Postgraduate Coursework Program Learning Goals and Outcomes, see Part B of the course outline.

<table>
<thead>
<tr>
<th>C2</th>
<th>CT6: (ix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>None</td>
</tr>
<tr>
<td>E1</td>
<td>None</td>
</tr>
<tr>
<td>E2</td>
<td>None</td>
</tr>
</tbody>
</table>

**Business Postgraduate Coursework Program Learning Goals and Outcomes**

**Knowledge: Our graduates will have current disciplinary or interdisciplinary knowledge applicable in local and global contexts.**

You should be able to identify and apply current knowledge of disciplinary or interdisciplinary theory and professional practice to business in local and global environments.

**2. Critical thinking and problem solving: Our graduates will have critical thinking and problem solving skills applicable to business and management practice or issues.**

You should be able to identify, research and analyse complex issues and problems in business and/or management, and propose appropriate and well-justified solutions.

**3. Communication: Our graduates will be effective communicators in professional contexts.**

You should be able to:

- a. Produce written documents that communicate complex disciplinary ideas and information effectively for the intended audience and purpose, and
- b. Produce oral presentations that communicate complex disciplinary ideas and information effectively for the intended audience and purpose.

**4. Teamwork: Our graduates will be effective team participants.**

You should be able to participate collaboratively and responsibly in teams, and reflect on your own teamwork, and on the team’s processes and ability to achieve outcomes.
5. Ethical, social and environmental responsibility: Our graduates will have a sound awareness of ethical, social, cultural and environmental implications of business issues and practice. You should be able to:
   a. Identify and assess ethical, environmental and/or sustainability considerations in business decision-making and practice, and
   b. Consider social and cultural implications of business and/or management practice.

6. Leadership: Our graduates will have an understanding of effective leadership. (MBA and MBT programs only).
You should be able to reflect on your personal leadership experience, and on the capabilities necessary for leadership.

The following table shows how the Course Learning Outcomes relate to the overall Program Learning Goals and Outcomes, and indicates where these are assessed (they may also be developed in tutorials and other activities):

<table>
<thead>
<tr>
<th>Program Learning Goals and Outcomes</th>
<th>Course Learning Outcomes</th>
<th>Course Assessment Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>This course helps you to achieve the following learning goals for all Business postgraduate coursework:</td>
<td>On successful completion of the course, you should be able to:</td>
<td>This learning outcome will be assessed in the following items:</td>
</tr>
<tr>
<td>1 Knowledge</td>
<td>Learning outcomes A1 – E2</td>
<td>• Homework Problems</td>
</tr>
<tr>
<td>2 Critical thinking and problem solving</td>
<td>Learning outcomes A1 – E2</td>
<td>• Mid-session exam</td>
</tr>
<tr>
<td>3a Written communication</td>
<td>Learning outcomes E1 – E2</td>
<td>• Assignment</td>
</tr>
<tr>
<td>3b Oral communication</td>
<td>Learning outcomes E1 - E2</td>
<td>• Final Exam</td>
</tr>
<tr>
<td>4 Teamwork</td>
<td>Learning outcomes E2</td>
<td>• Group assignment</td>
</tr>
<tr>
<td>5a. Ethical, social and environmental responsibility</td>
<td>Not specifically addressed in this course</td>
<td>• Not specifically assessed in this course</td>
</tr>
<tr>
<td>5b. Social and cultural awareness</td>
<td>Not specifically addressed in this course</td>
<td>• Not specifically assessed in this course</td>
</tr>
</tbody>
</table>
3  LEARNING AND TEACHING ACTIVITIES

3.1  Approach to Learning and Teaching in the Course

Lectures will review the main topics and provide coverage of the course concepts. They are an opportunity for students to develop an understanding of the main topics covered in the course and the level of knowledge expected. They provide a guide to the course of study during the session and the material students need to read and review. Students should read the prescribed readings prior to the lecture.

Homework problem discussions and in-class activities are for students to ask questions on aspects of the course that need further clarification, and to interact with other students in the course. Students need to attempt the homework problems alone first and identify problems that require closer review. Students are strongly encouraged to work in teams as it is an opportunity to learn from other students and to develop teamwork skills.

3.2  Learning Activities and Teaching Strategies

It is expected that students will take a pro-active approach to learning. The course is organised into learning activities.

By its nature, the actuarial program develops problem-solving and professional skills, and all activities contribute to that development. Thus, special care is taken when designing in-class activities, homework problems and optional readings.

Students are expected to perform these activities in the following time frame (for the outcomes of week $k$):

<table>
<thead>
<tr>
<th>Week $k-1$</th>
<th>Week $k$</th>
<th>Week $k+1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required readings</td>
<td>Attend lecture</td>
<td>Attend in-class discussion of homework problems and review solutions</td>
</tr>
<tr>
<td>Have a first look at the homework problems (if possible, in a team)</td>
<td>Attempt homework problems (if possible, in a team), and prepare questions</td>
<td>Review relevant past quizzes and final exam questions</td>
</tr>
<tr>
<td></td>
<td>Review lecture notes, and seek help if needed</td>
<td>Review recorded lecture at &quot;theBox&quot;</td>
</tr>
<tr>
<td></td>
<td>Review recorded lecture at &quot;theBox&quot;</td>
<td>Optional readings and exercises</td>
</tr>
</tbody>
</table>

Thus, you should, in a given week, work on these three different stages for their corresponding three different course weeks. Thanks to the 12-weeks-in-13 model, homework problems are discussed in Week $k+1$.

Detailed information about these activities for each week is available on Moodle (see also the summary table at the end of this document).

Tutorials are for students to ask questions on aspects of the course that need further clarification, to develop problem solving skills, and to interact with other students in the course. Students need to attempt the tutorial problems prior to the tutorial and identify problems that require further discussion. They are an opportunity to learn from other students and to develop team skills by working on problems with other students.
4 ASSESSMENT

4.1 Formal Requirements
In order to pass the course you must complete and submit all components of assessment at or before the due times. Late assessment submissions will not be marked. It is important that students be punctual and reliable when submitting assessment. 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. University regulations indicate that if students attend less than eighty per cent of scheduled classes they may be refused final assessment.

In order to pass the course, you must achieve a composite mark of at least 50. Students achieving an average of 65% or higher of ACTL5103 (1/3 of grade) and ACTL5104 (2/3 of grade) marks will be recommended for exemption from the professional CT4 examination. Students achieving an average of 65% or higher of ACTL5103 (1/3 of grade) and ACTL5106 (2/3 of grade) marks will be recommended for exemption from the professional CT6 examination.

ACTUARIES INSTITUTE OF AUSTRALIA
The Actuaries Institute of Australia (IAAust) allows students to become IAAust University Subscribers free of charge. Full time undergraduates studying at an Institute accredited university who are members of a university student actuarial society are eligible. To sign up, go to https://www.actuaries.asn.au/becoming-an-actuary/becoming-a-university-subscriber

The University Subscriber offer is not a membership of the IAAust but a subscription to receive information on career opportunities, invitations to selected IAAust events and online publications. You might also consider joining the IAAust – there are advantages in doing so while a full-time student. For membership information, go to https://www.actuaries.asn.au/becoming-an-actuary/becoming-a-member
4.2 Assessment Details
Assessment of your performance in the course will be done through a number of tasks, whose list you will find in the following table with relevant details.

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Weighting</th>
<th>Length</th>
<th>Topics Covered</th>
<th>Learning Outcomes Assessed</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz</td>
<td>15%</td>
<td>1 hour</td>
<td>Topics covered in Weeks 1-3 Lectures</td>
<td>A1, A2, A3, A4, B3</td>
<td>26 August 6pm-7pm</td>
</tr>
<tr>
<td>Presentations</td>
<td>3%</td>
<td>During Lectures</td>
<td>TBA</td>
<td>A1, A2, A3, A4, B1, B2, B3, C1, C2, D1, D2, F1</td>
<td>Week 2 - 13</td>
</tr>
<tr>
<td>Assignment</td>
<td>12%</td>
<td>N/A</td>
<td>Time Series</td>
<td>D1, D2, F1</td>
<td>23 October 5:00pm</td>
</tr>
<tr>
<td>Final Examination</td>
<td>70%</td>
<td>2 hours</td>
<td>Topics covered in Weeks 1-12 Lectures</td>
<td>B1, B2, C1, C2, D1, D2, E1</td>
<td>TBA</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3 Assessment Format
In order to pass the course student must perform satisfactorily in all course assessment components.

Midterm
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 there will be a 1-hour quiz during the session. The quiz will be closed book. Students will only be allowed to bring the UNANNOTATED text "Formulae and Tables for Actuarial Examinations" into the quiz.

Normal examination rules apply to the conduct of the midterm. UNSW approved calculators will be allowed in the midterm 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.

The in-class midterm require written responses, with students earning marks for correct mathematical working as well as part marks for incorrect responses with correct method and reasoning. They test not only your knowledge of the material, but also the depth of your understanding of it. They assist in the development of Business School Postgraduate Coursework Program Learning Goals and Outcomes 1, 2 and 3.
Presentations
Students will be assessed on their ability to speak in front of their peers. This is in fulfilment of the Business School Postgraduate Coursework Program Learning Goals and Outcomes 1, 2 and 3. Presentation questions will be made available and each student assigned his/her presentation question one week before the presentation. All presentations will be conducted towards the end of the lecture.

Assignment
There will be one assignment for this course. The assignment will be a group assignment. Students will be assigned to a group randomly. Each group will be required to submit an assignment.

The assignment offers students the opportunity to engage in critical analysis, problem solving, team work and self-reflection, as well as to demonstrate their understanding of the concepts and perspectives that are central to actuarial studies. The assignment assists in the development of Business School Postgraduate Coursework Program Learning Goals and Outcomes 1, 2, 3 and 4.

The assignment report will be assessed on technical accuracy, how well it is written, and the quality of the assignment presentation.

The assignment questions, together with the marks allocated to all components of the assignment, will be made available to students on the course website in Week 5. A guide on effective teamwork will also be posted on the course website.

Students are reminded that the work they submit must be their own. This means that:

- The mathematical solutions you present are written up by you and your group members, without reference to any other group’s work.
- The statistical analysis and mathematical calculation you present is done by your own group’s programming code, which your group wrote and ran, without reference to any other group’s work.
- Any spreadsheet solutions you present are from your own group’s spreadsheets, which your group developed, without any reference to any other group’s work.

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. Preparation for the final exam contributes to developing Business School Postgraduate Coursework Program Learning Goals and Outcomes 1, 2 and 3.

The final examination will be a two-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. This must not be annotated. Students may bring their own calculators. All calculators must be either UNSW approved.

4.4 Assignment Submission Procedure

Assignment reports must be submitted via the Turnitin submission box that will be made available on the course website. One group member is to submit the assignment on behalf of the team. Turnitin reports on any similarities between their own cohort’s assignments, and also with regard to other sources (such as the internet or all assignments submitted all around the world via Turnitin). More information is available at:

http://elearning.unsw.edu.au/turnitin/content/TurnItIn_Student_Support.cfm?ss=0
Please read this page, as we will assume that its content is familiar to you. You will be able to make multiple submissions and have access to the originality reports.

4.5 Late Submission

The School of Risk and 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.

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.

5 COURSE RESOURCES

Textbooks

The prescribed textbooks for the course are:

- Formulae and Tables for Actuarial Examinations of the Faculty of Actuaries and the Institute of Actuaries
- Lecture slides (provided on Moodle)

Suggested (optional) readings are:

- [C4] The Actuarial Education Company (2010), CT4 Combined Materials Pack Chapters 1 to 6, ActEd. (This is the Institute of Actuaries study material for the CT4 exam. Invaluable if you have to sit the exam later. Only the syllabus can be downloaded for free.)
- [C6] The Actuarial Education Company (2010), CT6 Combined Materials Pack Chapters 12 to 14, ActEd. (This is the Institute of Actuaries study material for the CT5 exam. Invaluable if you have to sit the exam later. Only the syllabus can be downloaded for free.)

Formulae & Tables
Students will only be allowed to bring into the examinations for the Actuarial courses 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 bookstore, the UK Institute of Actuaries or from ActEd Australia. Visit the ActEd website at: http://www.acted.com.au.

Moodle
This course will use Moodle for communication with students.

Moodle 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.

6 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.
## 7 COURSE SCHEDULE

### Lecture Schedule

Lectures start in Week 1 and finish in Week 12.

<table>
<thead>
<tr>
<th>LECTURE SCHEDULE</th>
<th>Week</th>
<th>Topic</th>
<th>Reference</th>
</tr>
</thead>
</table>
|                  | Week 1 29 July | Introduction to the course  
Principles of actuarial modelling  
Introduction to stochastic processes  
Introduction to Markov Chains  
Chapman-Kolmogorov equations  
Classification of states | Readings  
Ross, 11th Edition, Chapter 4 (4.1-4.3)  
Ross, 10th Edition, Chapter 2(2.8), Chapter 4 (4.1-4.3)  
Reference  
ACTED Chapter 1 and 2 CT4 |
|                  | Week 2 5 August | Markov Processes  
Limiting Probabilities  
Mean time in transient states  
Gambler’s ruin  
Branching processes  
Time reversible Markov chains | Readings  
Ross, 11th Edition, Chapter 4 (4.4, 4.5.1, 4.6-4.8)  
Ross, 10th Edition, Chapter 4 (4.4, 4.5.1, 4.6-4.8)  
Reference  
ACTED Chapter 3 CT4 |
|                  | Week 3 12 August | Exponential Distribution  
Poisson Process  
Generalizations of the Poisson Process | Readings  
Ross, 11th Edition, Chapter 5  
Ross, 10th Edition, Chapter 5  
Reference  
ACTED Chapter 5 CT4 |
|                  | Week 4 19 August | Continuous Time Markov Chains  
Transition probabilities  
Kolmogorov equations  
Limiting probabilities | Readings  
Ross, 11th Edition, Chapter 6 (6.1-6.5)  
Ross, 10th Edition, Chapter 6 (6.1-6.5)  
Reference  
ACTED Chapters 6 CT4 |
|                  | Week 5 26 August | Actuarial applications | Reference  
ACTED Chapter 4 and 6 CT4 |
|                  | Week 6 2 September | Actuarial applications (continued)  
Introduction to time series  
Properties of a univariate time series  
Trends, seasonal cycles, transformation | Readings  
Chan, Chapters 1  
Reference  
ACTED Chapter 4 and 6 CT4  
ACTED Chapter 12 and 13 CT6 |
|                  | Week 7 9 September | Time Series  
Sample correlation functions | Readings  
Chan, Chapter 2 and 3 |
<table>
<thead>
<tr>
<th>Week 8 16 September</th>
<th>Time Series</th>
<th>ARMA models</th>
<th>Model parameter estimations</th>
<th>Partial ACF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reference</td>
<td>Channel, Chapters 3 and 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACTED Chapter 12 and 13 CT6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 9 23 September</td>
<td>Time Series</td>
<td>Order selections</td>
<td>Residual analysis</td>
<td>Model building</td>
</tr>
<tr>
<td></td>
<td>Reference</td>
<td>Channel, Chapter 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACTED Chapter 12 and 13 CT6</td>
<td></td>
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</tr>
</tbody>
</table>

**Mid-semester break: Saturday 26 September - Monday 5 October inclusive**

<table>
<thead>
<tr>
<th>Week 10 7 October</th>
<th>Time Series</th>
<th>Nonstationarity</th>
<th>Unit root test</th>
<th>Introduction to forecasting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reference</td>
<td>Channel, Chapters 8 and 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 11 14 October</td>
<td>Time Series</td>
<td>Simple forecasts</td>
<td>Box-Jenkins approach</td>
<td>Introduction to Brownian motion</td>
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**23 October 2015, 5:00pm Assignment Due**

<table>
<thead>
<tr>
<th>Week 12 21 October</th>
<th>Introduction to Simulation</th>
<th>Generating continuous random variables</th>
<th>Simulating discrete random variables</th>
<th>Stochastic Process Simulation</th>
<th>Multivariate normal</th>
<th>Variance Reduction Techniques</th>
<th>Number of runs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 13 28 October</td>
<td>NO LECTURES</td>
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