ACTL5104
Actuarial Statistics

Course Outline
Semester 1, 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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Dear Students
Welcome to ACTL5104 Actuarial Statistics.

This course is one of the elective actuarial courses for the Master of Actuarial Studies. It corresponds to a major component of the CT4 course of the Institute of Actuaries/Faculty of Actuaries.

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 its contents.

If you have any questions about the course at any time, please contact me.

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

Adam Wenqiang Shao – Lecturer in charge
Michael Sherris – Course co-ordinator
PART A: COURSE-SPECIFIC INFORMATION

1 STAFF CONTACT DETAILS
The Course Lecturer-in-charge is Dr Adam Wenqiang Shao. He is responsible for the teaching and assessment of the course. All matters to do with the course should be directed to Adam. Consultation time: Tuesday 4.30 – 5.30 pm.

The Course Co-ordinator is Michael Sherris. He has responsibility for the professional accreditation requirements of the course.

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Email</th>
<th>Room</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer-in-charge</td>
<td>Adam W. Shao</td>
<td><a href="mailto:wenqiang.shao@unsw.edu.au">wenqiang.shao@unsw.edu.au</a></td>
<td>NICTA Building E318</td>
<td>9385 7005</td>
</tr>
<tr>
<td>Course co-ordinator</td>
<td>Michael Sherris</td>
<td><a href="mailto:m.sherris@unsw.edu.au">m.sherris@unsw.edu.au</a></td>
<td>Business School 644</td>
<td>9385 2333</td>
</tr>
</tbody>
</table>

2 COURSE DETAILS

2.1 Teaching Times and Locations
The course consists of weekly lectures which start in Week 1 (to Week 12): The lectures are held **Tuesday 6-9pm in Colombo Theatre A**.

The class will combine the lecture and tutorial and will involve interactive learning where participation is highly encouraged. To get the most out of the course, students will need to ensure they cover the modules’ contents and complete assigned homework problems in advance of the class.

2.2 Units of Credit
The course is worth 6 units of credit.
There is no parallel teaching in this course.

2.3 Summary of Course
This course covers survival models and their estimation as well as applications in insurance and finance. Specific topics include: the concept of survival models and actuarial notation; estimation of lifetime distributions; multiple state models; maximum likelihood estimation of transition intensities; the binomial model of mortality and its estimation; models with transition intensities depending on age and duration; the census approximation and formulae; statistical comparison of crude rates with a standard table; graduation of crude estimates and tests of fidelity and smoothness; analysis of mortality/morbidity and the main forms of selection.

This course covers material in the Subject CT4 Models of the Institute of Actuaries, covering Units 5-13 of CT4.

2.4 Course Aims and Relationship to Other Courses
At the end of the course students should be able to:
A. Assess the properties of a model involving survival or transition intensities and apply to real-life data for insurance and finance applications.
B. Use actuarial statistics techniques to assess probability models and data.
C. Understand and discuss ethical issues and implications of the modelling introduced in the course.

This course covers the development and application of statistical techniques to practical actuarial problems. Examples will be drawn from the insurance and financial markets. Students are assumed to have a good knowledge of ACTL5101 and ACTL5103.

Particularly important is the material on statistical estimation and regression techniques covered in ACTL5101. If your knowledge on this topic area requires revision it is important that you revise this material as soon as possible. The assumed knowledge of the course includes a good understanding of mathematics in calculus and linear algebra.

2.5 Student Learning Outcomes

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. These are:

1. Explain the concept of survival models
2. Describe estimation procedures for lifetime distributions
3. Describe statistical models of transfers between multiple states, including processes with single or multiple decrements, and derive relationships between probabilities of transfer and transition intensities
4. Derive maximum likelihood estimators for the transition intensities in models of transfers between states with piecewise constant transition intensities
5. Describe the Binomial model of mortality, derive a maximum likelihood estimator for the probability of death and compare the Binomial model with the multiple state models
6. Describe how to estimate transition intensities depending on age, exactly or using the census approximation.
7. Describe how to test crude estimates for consistency with a standard table or a set of graduated estimates, and describe the process of graduation.
8. Describe the principal forms of mortality and morbidity heterogeneity in a population and the main forms of selection
10 Understand and discuss the ethical dimensions and implications of the modelling introduced in the course

The course covers the following aims and syllabus items of the Institute of Actuaries courses:

<table>
<thead>
<tr>
<th>Course Learning Outcome</th>
<th>Institute of Actuaries Syllabus aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Survival Models v 1-8 (Chapter 7 CT4 notes)</td>
</tr>
<tr>
<td>2</td>
<td>Estimating the lifetime distribution function and Proportional hazards models vi 1-5 (Chapter 8 and 9 CT4 notes)</td>
</tr>
<tr>
<td>3</td>
<td>Markov processes and survival models iv 5-7 (Chapters 5 and 6 CT4 notes)</td>
</tr>
</tbody>
</table>
The Learning Outcomes in this course also help you to achieve some of the overall Program Learning Goals and Outcomes for all undergraduate students in the UNSW 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’).

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**Business Undergraduate Program Learning Goals and Outcomes**

1. **Knowledge:** Our graduates will have in-depth disciplinary knowledge applicable in local and global contexts.
   You should be able to select and apply disciplinary knowledge to business situations in a local and global environment.

2. **Critical thinking and problem solving:** Our graduates will be critical thinkers and effective problem solvers.
   You should be able to identify and research issues in business situations, analyse the issues, and propose appropriate and well-justified solutions.

3. **Communication:** Our graduates will be effective professional communicators.
   You should be able to:
   a. Prepare written documents that are clear and concise, using appropriate style and presentation for the intended audience, purpose and context, and
   b. Prepare and deliver oral presentations that are clear, focused, well-structured, and delivered in a professional manner.

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 the ethical, social, cultural and environmental implications of business practice.
   You should be able to:
   a. Identify and assess ethical, environmental and/or sustainability considerations in business decision-making and practice, and
   b. Identify social and cultural implications of business situations.

The following table shows how your 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):
Program Learning Goals and Outcomes | Course Learning Outcomes | Course Assessment Item
--- | --- | ---
This course helps you to achieve the following learning goals for all Business undergraduate students: | On successful completion of the course, you should be able to: | This learning outcome will be assessed in the following items:
1 | Knowledge | Learning Outcomes 1-8 | • Tutorial Problems
• Mid-session exam
• Final Exam
2 | Critical thinking and problem solving | Learning Outcomes 1-8 | • Tutorial Problems
• Mid-session exam
• Final Exam
3a | Written communication | Learning Outcomes 1-8 | • Assignment
• Mid-session exam
• Final exam
3b | Oral communication | Communicate ideas in a succinct and clear manner. | • Part of tutorial participation but not specifically assessed.
4 | Teamwork | Work collaboratively to complete a task. | • Part of tutorial participation but not specifically assessed.
5a. | Ethical, environmental and sustainability responsibility | Identify and assess ethical, environmental and/or sustainability considerations in business decision-making and practice. (Learning Outcome 9) | • Assignment
5b. | Social and cultural awareness | Consider social and cultural implications of business and/or management practice. (Learning Outcome 9) | • Assignment

3 LEARNING AND TEACHING ACTIVITIES

3.1 Approach to Learning and Teaching in the Course
The approach to learning and teaching is to actively engage students in the learning process by guiding students in developing their understanding of course topics and using problems for students to reflect on and gain deeper understanding of the more challenging applications of the course material.

The purpose of the lectures is to introduce and explain concepts in the student learning outcomes of the Course. It is expected that students come to lectures having read the relevant text material, lecture notes or lecture slides. Each lecture will provide an overview of the topics and will focus on explaining concepts and issues along with applications and practical issues. The role of the lecture is also to provide students with an opportunity to reinforce the major concepts. Lectures are designed to ensure students have grasped the key concepts and aims of the course and will not necessarily over all topic material in detail. Completing tutorial problems and other problems from the textbook is the best way to learn much of the course techniques.
Tutorials are used for active smaller group learning. They will review main concepts, provide an opportunity for students to ask questions and to work through problems to reinforce key concepts and encourage active learning.

3.2 Learning Activities and Teaching Strategies

The course references, 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. You would normally expect to spend at least 10 hours per week studying the course. Regular study, completing problems and attending tutorials throughout the course is the best way to master the course and achieve a successful outcome.

The learning activities of this course involve four key components – the lectures, the tutorials, the assessment including the assignment, and your private study. The role of the lecture is to help you understand the context of the topic as well as work through the difficult points. Tutorials allow you to deepen your knowledge of the course and to work with other students on problems enhancing your understanding. The assignment presents you with a practical application of course concepts. Your private study is the most important component of this course. Weekly readings, solving problems, and your own topic summaries should be considered as a basis of a regular private study regime. Keeping up to date is very important and each week builds on the prior week so it is important that you have your study regime organised early.

4 ASSESSMENT

4.1 Formal Requirements

In order to pass this course, you must:
- achieve a composite mark of at least 50; and
- make a satisfactory attempt at all assessment tasks (see below).

Students must complete and submit all components of assessment at or before the due times. 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; see Part B of the Course Outline for details.

A professional CT4 exemption is determined by a weighted average of ACTL5103 (1/3rd) and ACTL5104 (2/3rds) marks. This average must be 65% or higher in order to be recommended for exemptions. If you do not achieve this exemption grade then you can still gain the exemption by successfully completing the Institute of Actuaries equivalent examination as soon as practical after the UNSW course.
4.2 Assessment Details

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Weighting</th>
<th>Length</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-Session Exam</td>
<td>15%</td>
<td>1 hour</td>
<td>Tuesday 14 April</td>
</tr>
<tr>
<td>Assignment</td>
<td>15%</td>
<td></td>
<td>Assignment Part (a) will be due Tuesday 31 March 5.55pm and Assignment Part (b) will be due Tuesday 5 May 5.55pm.</td>
</tr>
<tr>
<td>Final Exam</td>
<td>70%</td>
<td>2 hours</td>
<td>University Exam Period</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Feedback will be provided to students after their assessments. Students should note that the final assessment can involve standardisation and scaling of overall marks.

Mid-term exam
There will be one written answer mid-session exam in following the mid-session break in week 6 of 50 minutes duration. The mid-term exam will take place on Tuesday 14 April, from 6pm to 7 pm in Lecture Theatre (Colombo Theatre A). The mid-session exam will be closed book. Students will only be allowed to bring the text "Formulae and Tables for Actuarial Examinations".

Normal examination rules apply to the conduct of mid-term exams. Calculators will be allowed in the mid-term and 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 course exams 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 their knowledge of the material, but also the depth of their understanding of it.

Assignment
The assignment will involve two parts. One will require writing a short report considering a practical issue involving ethical, social and environmental implications of business practice and the other the analysis of a data set. Full details of the assignment tasks are provided on the Moodle course web site. Assignment Part (a) will be due Tuesday 31 March 5.55pm and Assignment Part (b) will be due Tuesday 5 May 5.55pm.

This course is using the Review software for marking and feedback for the assignment. The Review login is https://unsw.review-edu.com/unsw

Information on accessing Review will be provided to students with further details of the assignment. You won't have access to Review until you are advised.

Final examination
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. 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.

### 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
The prescribed textbook for the course is:
- Core Reading for Subject CT4 Models published by The Institute of Actuaries.
- ActEd Course Notes for Subject CT4 Models.

Additional, recommended references are:
  - Chapter 2 Basic Quantities and Models, Chapter 3 Censoring and Truncation, Chapter 4 Nonparametric estimation, Chapter 8 Semi-parametric proportional hazards regression and Chapter 9 Refinements of Semi-parametric proportional hazards.
  - Chapter 1 on Mortality Measures, Chapters 11, 12, 14, 15 and 16 on Graduation topics, Chapter 19 on Social and Economic Factors Affecting Mortality, and Chapter 9 on Trend and Forecasting.
  - Estimation of Tabular Models

The course draws on and further develops concepts covered in ACTL5101 (Estimation, Regression) and ACTL5103 (Markov Chains). Students are encouraged to review these concepts as required early in the course.
**Formulae & Tables**
The only text students are allowed to bring into the examinations for the actuarial courses is the text "Formulae and Tables for Actuarial Examinations". It must not be annotated. All students in the actuarial courses should purchase a copy of this text if they wish to use it in tutorials, mid-session exams and the final examinations. 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](http://www.acted.com.au).

**Course website**
The course Moodle website is available from the UNSW TELT platform: [http://elearning.unsw.edu.au/](http://elearning.unsw.edu.au/)

To access the Moodle online support site for students, follow the links from that website to UNSW Moodle Support/Support for Students. Additional technical support can be obtained from itservicecentre@unsw.edu.au (02 9385 1333). All course contents will be available from the course website (except for the module “Back to Basics” which is available on the Moodle ACTL students common website). **It is essential that you visit the site regularly (at least weekly) to see any notices posted there by the course coordinator.**

**The Actuaries Institute**
The Actuaries Institute allows students to become 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 [http://www.actuaries.asn.au/becoming-an-actuary/becoming-a-university-subscriber](http://www.actuaries.asn.au/becoming-an-actuary/becoming-a-university-subscriber)

### 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. In this course we will seek feedback at least at the end of the session. Feedback received for the 2014 offering of the course has been used to improve the way the course will be taught in 2015. In particular students indicated a more formal review of prior week’s topics throughout the course. Timing of assessment tasks has also been modified to ensure students have the require time and background to benefit from the assessment tasks and feedback.
## 7 COURSE SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Topic</th>
<th>References</th>
<th>Notes and Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Topic Overview</td>
<td>Core Reading CT4 Unit 5</td>
<td></td>
</tr>
<tr>
<td>3 March</td>
<td>Survival Models and The Life Table</td>
<td>CT4 ActEd Course Notes Chapter 7</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Klein, J. P. and M. L. Moeschberger, Chapter 2 - 2.1-2.4</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Elandt-Johnson and. Johnson, 3.1 to 3.11, 4.1 to 4.8</td>
<td></td>
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<tr>
<td>Week 2</td>
<td>Estimating Life Time Distributions</td>
<td>Core Reading CT4 Unit 6</td>
<td></td>
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<tr>
<td>10 March</td>
<td></td>
<td>CT4 ActEd Course Notes Chapter 8</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Klein, J. P. and M. L. Moeschberger, Chapters 3 and 4.</td>
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<tr>
<td>Week 3</td>
<td>Ethical and Social Responsibility Regression – review and introduction to GLM’s and Cox Regression</td>
<td>Lecture Notes</td>
<td></td>
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<tr>
<td>17 March</td>
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<tr>
<td>Week 4</td>
<td>The Cox Regression Model</td>
<td>Core Reading CT4 Unit 7</td>
<td></td>
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<tr>
<td>24 March</td>
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<td>CT4 ActEd Course Notes Chapter 9</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Klein, J. P. and M. L. Moeschberger, Chapter 2 - 2.5, Chapters 8, 11.2</td>
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<tr>
<td>Week 5</td>
<td>Estimation in the Markov Model</td>
<td>Core Reading CT4 Unit 8</td>
<td>Assignment Part (a) Due Tuesday 31 March 5.55pm</td>
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<tr>
<td>31 March</td>
<td></td>
<td>CT4 ActEd Course Notes Chapter 3, 4, 5 and 6</td>
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<tr>
<td></td>
<td>Mid-semester break: Good Friday 3rd April - Sunday 12th April</td>
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<tr>
<td>Week 6</td>
<td>Estimation in the Markov Model</td>
<td>Core Reading CT4 Unit 8</td>
<td>Midsession test in class Tuesday 14 April</td>
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<tr>
<td>14 April</td>
<td></td>
<td>CT4 ActEd Course Notes Chapter 3, 4, 5 and 6</td>
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<tr>
<td>Week</td>
<td>Topic</td>
<td>Reading</td>
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<tr>
<td>7 21 April</td>
<td>Binomial and Poisson models</td>
<td>Core Reading CT4 Unit 9&lt;br&gt;CT4 ActEd Course Notes&lt;br&gt;Chapter 10</td>
<td></td>
</tr>
<tr>
<td>8 28 April</td>
<td>Exposed to Risk</td>
<td>Core Reading CT4 Unit 10&lt;br&gt;CT4 ActEd Course Notes&lt;br&gt;Chapter 11</td>
<td></td>
</tr>
<tr>
<td>9 5 May</td>
<td>Graduation and Statistical Tests</td>
<td>Core Reading CT4 Unit 11&lt;br&gt;CT4 ActEd Course Notes&lt;br&gt;Chapter 12&lt;br&gt;Benjamin and Pollard, Chapter 11</td>
<td></td>
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<tr>
<td>10 12 May</td>
<td>Methods of Graduation</td>
<td>Core Reading CT4 Unit 12&lt;br&gt;CT4 ActEd Course Notes&lt;br&gt;Chapter 13&lt;br&gt;Benjamin and Pollard, Chapter 12, 14, 15 and 16</td>
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<tr>
<td>11 19 May</td>
<td>Mortality, Selection and Standardisation</td>
<td>Core Reading CT5 Unit 9&lt;br&gt;Benjamin and Pollard, Chapter 19</td>
<td></td>
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<tr>
<td>12 26 May</td>
<td>Mortality Projection Models Review</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>13 2 June</td>
<td>NO LECTURES</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assignment Part (b) due Tuesday 5 May 5.55pm