**STAT3035**

**Risk Theory**

**Course Description**

This course introduces the theory of compound Poisson processes, with a particular emphasis on their application to insurance portfolios (though their applicability in other areas is also noted).

Topics include: Modelling loss distributions; Skewed parametric distribution families; Method of moments, method of percentiles and maximum likelihood estimation; Pearson goodness-of-fit testing for distribution assessment; Truncated and censored data, including applications to reinsurance and policy excess schemes; Random sums, convolutions and compound distributions, particularly for modeling aggregate claim distributions; Normal and gamma approximations to compound distributions; Compound Poisson process theory, including applications to insurance portfolio surplus processes; Ultimate and finite-time ruin probabilities; Adjustment coefficients and optimal reinsurance contracts.

<table>
<thead>
<tr>
<th>Semester and Year</th>
<th>S1 2015</th>
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<tbody>
<tr>
<td>Mode of Delivery</td>
<td>On campus</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>STAT3004</td>
</tr>
<tr>
<td>Incompatible Courses</td>
<td>N/A</td>
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<tr>
<td>Course Convener</td>
<td>Tim Higgins</td>
</tr>
<tr>
<td>Office Location:</td>
<td>CBE Building Room 4.30</td>
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<tr>
<td>Phone:</td>
<td>6125 4507</td>
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<tr>
<td>Email:</td>
<td><a href="mailto:tim.higgins@anu.edu.au">tim.higgins@anu.edu.au</a></td>
</tr>
<tr>
<td>Consultation hours:</td>
<td>To be advised</td>
</tr>
<tr>
<td>Bio and research interests</td>
<td>Tim Higgins is a Fellow of the Institute of Actuaries and worked in the Department of Treasury prior to joining RSFAS in 2002. He has a PhD in Statistics, and his research interests include income contingent loan theory and applications, retirement policy, and microsimulation modelling</td>
</tr>
<tr>
<td>Tutor(s) (optional)</td>
<td>Tutor names and contact details will be listed on Wattle</td>
</tr>
<tr>
<td>Student Administrators</td>
<td>Maria Lander</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:maria.lander@anu.edu.au">maria.lander@anu.edu.au</a></td>
</tr>
<tr>
<td></td>
<td>Office location: CBE Building Room 4.51</td>
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COURSE OVERVIEW

Learning Outcomes
To achieve an understanding of and facility in applying and communicating the following topics:

- Estimating using skewed distributions with and without the presence of censoring and truncation
- Aggregation of random quantities through compound distribution theory
- Compound Poisson process theory including approximation of boundary crossing probabilities as applied to calculating risk for insurance portfolios

Research-Led Teaching
The course convenor has numerous years of professional practice and has undertaken research in statistical and actuarial topic areas. Lectures in the course will be informed where possible by practical examples.

Continuous Improvement
We use feedback from students, professional bodies and staff to make regular improvements to the course. In response to this feedback, design improvements from the previous version of the course include:

- More inclusion of computer-based examples in lectures
- Changes to tutorial questions

Technology, Software, Equipment
There is no formal computing requirement for this course. However, Microsoft Excel and the free statistical computing software R will be used for demonstration of concepts during the course.

Co-teaching
Students from STAT3035 and STAT8035 will be taught Risk Theory in the same room and at the same time. Students from STAT8035 will have slightly different assessment tasks than students in STAT305, in the form of additional examination questions.

Student Feedback
All CBE courses are evaluated using Student Experience of Learning and Teaching (SELT) surveys, administered by Planning and Statistical Services at the ANU. These surveys are offered online, and students will be notified via email to their ANU address when surveys are available in each course. Feedback is used for course development so please take the time to respond thoughtfully. Course feedback is anonymous and provides the Colleges, University Education Committee and Academic Board with opportunities to recognise excellent teaching and to improve courses across the university. For more information on student surveys at ANU and reports on feedback provided on ANU courses, visit [http://unistats.anu.edu.au/surveys/sef/students/](http://unistats.anu.edu.au/surveys/sef/students/) and [http://unistats.anu.edu.au/surveys/sef/results/learning/](http://unistats.anu.edu.au/surveys/sef/results/learning/)
COURSE SCHEDULE

The course notes (available on Wattle) consist of five parts:

1 – Introduction
2 – Fitting Loss Distributions (including Generalised Linear Models (GLM))
3 – Reinsurance and Policy Excesses
4 – Aggregate Claims Modelling
5 – Ruin Theory

Following a brief introduction, in Section 2 we will investigate the random amount of individual claims, in the process introducing some new statistical distributions and learning how to choose which of these distributions best describes a set of observations on a portfolio. This will include an introduction to the theory and application of generalised linear models. Next, motivated by the fact that the claim paid by an insurer may be limited by reinsurance and policy excesses, in Section 3 we will briefly show how to adjust loss distributions to allow for truncation and censoring.

In Section 4 we will examine the total cost of all claims made on a portfolio over a fixed period of time (as opposed to individual claims), which means that we will have to develop techniques for dealing with sums of random amounts where the number of terms in the sum is itself random (since the random timing of claims means that the number which occur in any fixed period is a random variable). Finally, in Section 5, we shall discuss the long-term behaviour of insurance portfolios by modelling the overall income and cost structure through time.

<table>
<thead>
<tr>
<th>Week</th>
<th>Summary of Activities</th>
<th>Tutorial</th>
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| 1 (16 – 20 Feb) | • Course overview.  
• Section 1 – Introduction.  
| 2 (23 – 27 Feb) | • Section 2.4.1 – Gamma distribution.  
• Section 2.4.2 – Log normal distribution. | 0 |
| 3 (2 – 6 Mar) | • Section 2.4.3 – Weibull distribution.  
• Section 2.4.4 – Mixture distributions; Deriving the Pareto distribution. | 1 |
| 4 (9– 13 Mar) | • Section 2.4.4 – Deriving the negative binomial distribution.  
• Section 2.5 – Generalised linear models. | 2 |
| 5 (16 – 20 Mar) | • Section 2.5 – Generalised linear models (continued).  
• Section 3 – Reinsurance and policy excesses. Proportional, Excess-of-Loss and Stop-Loss reinsurance. Modelling individual claims with reinsurance. | 3 |
| 6 (23 – 27 Mar) | • Section 4.1-4.2 – Aggregate Claims Modelling: Collective Risk Model.  
Compound Poisson, Binomial and Negative Binomial distributions.  
• Section 4.2.4 – Compound distributions and reinsurance. | 4 |
| 7 (30 Mar – 3 Apr) | • Section 4.3 – Approximating Compound Distributions for the Collective Risk Model. | 5 |
### COURSE ASSESSMENT

**Assessment Summary**

<table>
<thead>
<tr>
<th>Item</th>
<th>Title</th>
<th>Value</th>
<th>Date</th>
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<tbody>
<tr>
<td>1</td>
<td>Mid-Semester Examination</td>
<td>30%</td>
<td>To be determined (Centrally timetabled)</td>
</tr>
<tr>
<td>2</td>
<td>Final Examination</td>
<td>70%</td>
<td>To be determined (Centrally timetabled)</td>
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**Assessment Task 1: Mid-Semester Examination**

**Details of task:** 10 minute reading time; 1 ½ hour writing time

The mid-semester examination is redeemable. There will be no special examinations for the mid-semester exam. If you do not sit the mid-semester examination the weighting will be moved to the final exam.

**Assessment Task 2: Final Examination**

**Details of task:** 15 minute reading time; 3 hour writing time

Both the mid-semester and final examinations will be closed book exams. A formula sheet will be handed out at the start of the exams. Copies of the formula sheets for the mid-semester and final examinations will be made available through Wattle prior to the exams.

**Scaling**

Your final mark for the course will be based on the raw marks allocated for each examination. However, your final mark may not be the same number as produced by that formula, as marks may be scaled. Any scaling applied will preserve the rank order of raw marks (i.e. if your raw mark exceeds that of another student, then your scaled mark will exceed or equal the scaled mark of that student), and may be either up or down.
READING LISTS

Comprehensive lecture notes will be made available on Wattle. There are no prescribed texts besides the lecture notes, however, there are optional texts listed below if you wish to read further material.

Optional Reading
D.C.M. Dickson (2005)
*Insurance Risk and Ruin*
Cambridge University Press

*Insurance Risk Models*
Society of Actuaries

Hossack, Polland and Zehnwirth (1983)
*Introductory Statistics with Applications in General Insurance*
Cambridge University Press

Hogg and Klugman (1984)
*Loss Distributions*
John Wiley & Sons

COMMUNICATION

Email
If necessary, the lecturers and tutors for this course will contact students on their official ANU student email address. Information about your enrolment and fees from the Registrar and Student Services’ office will also be sent to this email address.

Announcements
Students are expected to check the Wattle site for announcements about this course, e.g. changes to timetables or notifications of cancellations. Notifications of emergency cancellations of lectures or tutorials will be posted on the door of the relevant room.

Course URLs
More information about this course may be found on:

- Programs and Courses (http://programsandcourses.anu.edu.au/2015/Catalogue )
- the College of Business and Economics website (http://cbe.anu.edu/courses) and
- Wattle (https://wattle.anu.edu.au), the University's online learning environment. Log on to Wattle using your student number and your ISIS password.

TUTORIAL AND /OR SEMINAR REGISTRATION

Enrolment in tutorials will be completed online using the CBE Electronic Teaching Assistant (ETA). To enrol, follow these instructions:

1. Go to http://eta.fec.anu.edu.au
2. You will see the Student Login page. To log into the system, enter your University ID (your student number) and password (your ISIS password) in the appropriate fields and hit the Login button.
3. Read any news items or announcements.
4. Select "Sign Up!" from the left-hand navigation bar.
5. Select your courses from the list. To select multiple courses, hold down the control key. On PCs, this is the Ctrl key; on Macs, it is the ⌘ key. Hold this key down while selecting courses with the mouse. Once courses are selected, hit the SUBMIT button.
6. A confirmation of class enrolments will be displayed. In addition, an email confirmation of class enrolments will be sent to your student account.
7. For security purposes, please ensure that you click the LOGOUT link on the confirmation page, or close the browser window when you have finished your selections.
8. If you experience any difficulties, please contact the School Office (see page 1 for contact details).
9. Students will have until 5pm Wednesday 25 February to finalise their enrolment in tutorials. After this time, students will be unable to change their tutorial enrolment.

POLICIES

The University offers a number of support services for students. Information on these is available online from http://students.anu.edu.au/studentlife/

ANU has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University’s academic standards, and implement them. You can find the University’s education policies and an explanatory glossary at: http://policies.anu.edu.au/

Students are expected to have read the Student Academic Integrity Policy before the commencement of their course.

Other key policies include:

- Student Assessment (Coursework)
- Student Surveys and Evaluations