

THE UNIVERSITY OF  
NEW SOUTH WALES



Australian School of Business  
School of Actuarial Studies

**ACTL5106**  
**INSURANCE RISK MODELS**

**COURSE OUTLINE**  
**SEMESTER 2, 2009**

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Sydney 2052 Australia

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Dear Students

Welcome to ACTL5106 Insurance Risk Models. This course is one of eight courses for the Master of Actuarial Studies. At this stage in your study, you must have completed courses ACTL5102, ACTL5101 and ACTL5103. If you have not completed ACTL5103, you should be concurrently enrolled for this course. These courses are part of the assumed knowledge for this course, although you may be allowed to enrol in this course without having enrolled in these courses depending on your background. If you are interested in working in the financial services industry, you may also wish to consider taking courses ACTL5105, ACTL5109, FINS3631 and FINS3640, and other risk management courses offered by the School of Actuarial Studies.

This course will provide you with the foundations of the classical and modern theories of the actuarial mathematics, statistics, and models used in non-life insurance actuarial practice. In this course, you will learn how to value or price and how to reserve for non-life (or general) insurance products. I 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 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.

Dr Benjamin Avanzi

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## 1. STAFF CONTACT DETAILS

The Course Coordinator and Lecturer in Charge is Dr Benjamin Avanzi:

| Staff              | E-mail                                                         | Room      | Telephone |
|--------------------|----------------------------------------------------------------|-----------|-----------|
| Dr Benjamin Avanzi | <a href="mailto:b.avanzi@unsw.edu.au">b.avanzi@unsw.edu.au</a> | Quad 2071 | 9385 9844 |

He is responsible for course administration, final assessment of the course and responsible for the lectures and related teaching and learning. His consultation times are on Mondays, 5pm to 7pm. Exam preparation consultation times will be advised through the course website.

Who should I contact?

- Questions about the lectures or homework questions: Dr Benjamin Avanzi, during their consultation times or by e-mail;
- Administrative enquiries about the course: Dr Benjamin Avanzi, during his consultation times or by e-mail;
- Enquiries about postgraduate coursework programs in Actuarial Studies: the Postgraduate Programs Coordinator (Dr Bernard Wong, [bernard.wong@unsw.edu.au](mailto:bernard.wong@unsw.edu.au)) or the Administrative Officer (Ms Bindya Subba, [b.subba@unsw.edu.au](mailto:b.subba@unsw.edu.au));
- Enrolment: the Administrative Officer (Ms Bindya Subba, [b.subba@unsw.edu.au](mailto:b.subba@unsw.edu.au)).

## 2. COURSE DETAILS

### 2.1 Teaching Times and Locations

This course consists of a 3 hour lecture.

The lecture is held on **Tuesdays from 6pm to 9pm in ASB 119.**

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 Units.

For professional recognition, a separate undergraduate course equivalent to ACTL5106 is offered to students enrolled in the Bachelor of Commerce and majoring in Actuarial Studies. Students enrolled in ACTL5106 **must only attend** the postgraduate lectures. Students attending the postgraduate course ACTL5106 must be enrolled in the Master of Actuarial Studies. Faculty and School policy does not allow undergraduate attendance at postgraduate lectures or postgraduate attendance at undergraduate lectures.

### 2.3 Summary of Course

This course will cover both the classical and the modern theory of the actuarial mathematics, statistics, and models used in non-life insurance actuarial practice. Topics covered include: risk models including individual and collective risk models (e.g. compound Poisson); probability of ruin; loss distributions and reinsurance; fitting distributions to insurance loss data; estimation of aggregate claims distribution; copulas; use of generalised linear models; Bayesian statistical models; premium rating and credibility; claims reserving for loss run-off data (IBNR techniques); and an introduction to both game and decision theory.

### 2.4 Course Aims and Relationship to Other Courses

At the end of the course students should be able to:

- A. Model the excess of aggregate premiums over aggregate losses at any point in the future and describe how the model can be used;
- B. Fit a distribution to data;
- C. Incorporate past experience (of a contract or insured) into pricing and reserving;
- D. Give an overview of basic decision and game theory;
- E. Implement the models introduced in the course using appropriate computer software.

This course covers the mathematical foundations of non-life insurance risk modelling. The assumed knowledge for this course is a solid foundation in ACTL5102, ACTL5101 and ACTL5103. Depending on their educational background, some students may be allowed to enrol in this course without having completed these courses. We advise you to consult the lecturer if you do not have the required background.

Students should have a solid background in mathematics and are assumed to be able to use a computer to analyse financial problems. You should be able to use a word processing package (such as WORD), a spreadsheet (such as EXCEL) and computational software (such as R, MATLAB, or MAPLE). Students are expected to develop their skills with R throughout the course.

## 2.5 Student Learning Outcomes

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

- A1. Calculate or approximate the distribution of the sum of losses, when their number is either deterministic or random;
- A2. Calculate the value of a reinsurance contract;
- A3. Describe the classical model of risk theory for the excess of aggregate premiums over aggregate losses (Cramér-Lundberg);
- A4. Determine, for simple cases, the probability that aggregate losses will exceed aggregate premiums at any point in the future;
- B1. Calculate descriptive statistics and identify candidate distributions for fitting a model to data;
- B2. Estimate parameters of a given distribution using complete or censored/truncated data;
- B3. Evaluate the goodness of fit of a model via a range of metrics;
- B4. Understand Generalised Linear Models (GLM) and apply them in simple situations;
- B5. Understand how to model dependence between random variables using copulas;
- C1. Determine the pure Bayesian premium of a loss, given its experience, using parametric or non-parametric models;
- C2. Determine the expected present value of future liabilities arising from claims already incurred;
- D1. Discuss and apply elements of both decision and game theory
- E1. Use R to implement the models introduced in the course

These learning outcomes relate to the ASB Graduate Attributes in the following way:

| Course Learning Outcomes | ASB Graduate Attributes                                     |
|--------------------------|-------------------------------------------------------------|
| All                      | 1. Critical thinking and problem solving                    |
| None                     | 2. Communication                                            |
| None                     | 3. Teamwork and leadership                                  |
| None                     | 4. Social, ethical and global perspectives                  |
| E1                       | 5. In-depth engagement with relevant disciplinary knowledge |
| E1 (All)                 | 6. Professional skills                                      |

This course corresponds largely with the actuarial professional subject CT6 Statistical Methods. ACTL5103 covers several topics from this subject as well (CT6 aims iii.1, vi, ix and x). The course's Learning Outcomes relate to the aims of Institute of Actuaries aims in the following way:

| Course Learning Outcomes | Institute of Actuaries aims |
|--------------------------|-----------------------------|
| A1                       | CT6: ii, iii                |
| A2                       | CT6: ii, iii                |
| A3                       | CT6: iv                     |
| A4                       | CT6: iv                     |
| B1                       | None                        |
| B2                       | None                        |
| B3                       | None                        |
| B4                       | CT6: viii                   |
| B5                       | None                        |
| C1                       | CT6: v                      |
| C2                       | CT6: vii                    |
| D1                       | CT6: i                      |
| E1                       | None                        |

### 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 team skills.

### 3.2 Learning Activities and Teaching Strategies

It is expected the students will take a pro-active approach to learning. The course is organised into learning activities given in the following table. The Course Aims and ASB Graduate Attributes they should develop are also indicated.

| Activity                                 | A | B | C | D | E | 1 | 2 | 3 | 4 | 5 | 6 |
|------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|
| Required readings                        | X | X | X | X | X | X |   |   |   | X | X |
| Lectures and in-class activities         | X | X | X | X | X | X | X | X | X | X | X |
| In-class discussion of homework problems | X | X | X | X | X | X | X | X |   | X | X |
| Optional readings                        | X | X | X | X | X | X |   |   |   | X | X |
| Optional exercises                       | X | X | X | X | X | X |   |   |   | X | X |

By nature, the actuarial program develops problem-solving and professional skills (ASB Graduate Attributes 1 and 6), and all activities contribute to that development. Thus, special care is taken when designing in-class activities, homework problems and optional readings in order to also develop the ASB Graduate Attributes 2 to 5.

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

| Week $k-1$                                                                               | Week $k$                                                                                                                                     | Week $k+1$                                                                                                                                                       |
|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Required readings<br>Have a first look at the homework problems (if possible, in a team) | Attend lecture<br>Attempt homework problems (if possible, in a team), and prepare questions<br>Review lecture notes, and seek help if needed | Attend in-class discussion of homework problems and review solutions<br>Review relevant past quizzes and final exam questions<br>Optional readings and exercises |

Thus, you should, in a given week, work on these three different stages for their corresponding three different course weeks. This proposed learning strategy should in itself develop the 6th ASB Graduate Attribute. Note that 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 the course website (see also the summary table at the end of this document). 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 any information posted on the website or received by e-mail. It is also your responsibility to keep the University informed of all changes to your contact details.

It is expected that you will spend at least ten hours per week studying this course. 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.

## 4. ASSESSMENT

### 4.1 Formal Requirements

In order to pass the course students must complete and submit all assessment items at or before the due times. Late assessment submissions will not be marked. It is important that students be punctual and reliable when submitting material. This is an important workplace requirement and students need to ensure they meet deadlines.

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

### 4.2 Assessment Details

Assessment of your performance in the course will be done through a number of tasks. These are listed in the table below.

| Assessment Task   | Weight | LO <sup>1</sup>                | ASB GA <sup>2</sup> | Length  | Due Date                          |
|-------------------|--------|--------------------------------|---------------------|---------|-----------------------------------|
| Quiz 1            | 7.5%   | Weeks 1-4:<br>A1-A4            | 1, 2, 5, 6          | 50 mins | 18 Aug 2009,<br>5.15pm-<br>6.05pm |
| Major Assignment  | 15%    | A1, B5, E1                     | 1, 2, 4, 5, 6       | N/a     | 18 Sep 2009,<br>9.55am<br>sharp   |
| Quiz 2            | 7.5%   | Weeks 5-9:<br>B1-B5, C1,<br>E1 | 1, 2, 5, 6          | 50 mins | 29 Sep 2009,<br>5.15pm-<br>6.05pm |
| Final examination | 70%    | All                            | 1, 2, 5, 6          | 3 hours | TBA                               |

In order to pass the course students must perform satisfactorily in all course assessment components.

Students achieving an average of 65% or higher according to the following formula will be recommended for exemption from the professional examination CT6:

1/3 of ACTL5103 grade plus 2/3 of ACTL5106 grade.

Exemptions from professional actuarial examinations require above average performance in the equivalent University course. Furthermore, it is a requirement towards exemption eligibility that the final examination weighting is at least 70%.

### In-Class Quizzes

There will be two in-class written answer quizzes in weeks 5 and 10 each of 50 minutes duration. **The quizzes will take place on Tuesdays, from 5.15pm to 6.05pm.** Venue will be advertised later. The in-class quizzes will be closed book. Students will only be allowed to bring the text "Formulae and Tables for Actuarial Examinations" into the in-class exams.

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<sup>1</sup> Course Learning Outcome that is assessed

<sup>2</sup> ASB Graduate Attribute that is assessed

Normal examination rules apply to the conduct of class quizzes. Calculators will be allowed in the class quizzes 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 either the quizzes or the final exam. It is the student's responsibility to be familiar with the rules governing the conduct of examinations.

The class quizzes 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. They assist in the development of ASB Graduate Attributes 1, 5 and 6.

### **Major Assignment**

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

The assignment offers students the opportunity to engage in independent research, engage in critical analysis, self-reflection and problem solving, as well as to demonstrate their understanding of the concepts and perspectives that are central to actuarial studies. A solid attempt at the assignment will contribute towards developing ASB Graduate Attributes 1, 2, 4, 5 and 6.

Full information about the major assignment is given at the end of the document.

### **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. Preparation for the final exam contributes to developing ASB Graduate Attributes 1, 2, 5 and 6.

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. This must not be annotated. Students may bring their own calculators. All calculators must be either UNSW or Actuarial Studies approved.

## **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.html>.

**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:

[http://wwwdocs.fce.unsw.edu.au/fce/EDU/harvard\\_ref\\_guide.pdf](http://wwwdocs.fce.unsw.edu.au/fce/EDU/harvard_ref_guide.pdf)

### 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

### Course references

The prescribed textbooks for the course are:

- [A] Bowers, N.L. Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J. (1997), *Actuarial Mathematics*, Society of Actuaries, 2nd Edition [A great classic for course aim A.]
- [B] Dalgaard, P. (2008), *Introductory Statistics with R*, Springer, 2nd Edition [Outcome E1. A reference book for the package R and its applications in statistics]
- [C] The Faculty of Actuaries and The Institute of Actuaries (2002), *Formulae and tables for examinations of the Faculty of Actuaries and The Institute of Actuaries*, ActEd [The formulae book that you are allowed to use, if unannotated, during the quizzes and the final exam]

Required additional readings are:

- [D] Dickson, D.C.M (1995), A review of Panjer's recursion formula and its applications, *British Actuarial Journal* 1:1, pp. 107-124 [Outcome A1. This paper can be downloaded on campus for free. It can also be downloaded from MyCourse]
- [E] Klugman, S. and Rioux, J. (2006), Toward a Unified Approach to Fitting Loss Models, *North American Actuarial Journal* 10:1, pp. 63-83 [Outcomes B1-B3. This paper can be downloaded free of charge from the website of the Society of Actuaries]
- [F] Klugman, S.A., Panjer, H.H. and Willmot, G.E. (2008), *Loss Models: From Data to Decisions*, John Wiley & Sons, 3rd Edition. [Outcome B5. A scanned version of Chapter 7 will be freely available on MyCourse.]
- [G] Frees, E.W. and Valdez, E.A. (1998), Understanding Relationships Using Copulas, *North American Actuarial Journal* 2:1, pp. 1-25 [Outcome B5. This paper can be downloaded free of charge from the website of the Society of Actuaries]
- [H] Haberman, S. and Renshaw, A.E. (1996), Generalized linear models and actuarial science, *The Statistician* 45:4 pp. 407-436 [Outcome B4. This paper can be downloaded on campus for free. It can also be downloaded from MyCourse.]
- [I] Boland, P.J. (2007), *Statistical and Probabilistic Methods in Actuarial Science*, Chapman & Hall/CRC [Outcome C2. A scanned version of Chapter 1 will be freely available on MyCourse.]
- [J] Valdez, E. (2004), 'Decisions and Games', Notes prepared for UNSW students [Outcome D1. This document will be made available on WebCT.]

Suggested (optional) readings are:

- [K] Nelsen, R.B. (2006), *An Introduction to Copulas*, Springer, 2nd Edition [Outcome B5. Chapter 2 is freely available from the Springer website and will be made available on WebCT]
- [L] De Jong, P. and Heller, G.Z. (2008), *Generalized Linear Models for Insurance Data*, Cambridge University Press [Outcome B4: an additional reference for GLM. A scanned version of Chapter 5 will be freely available on MyCourse.]
- [M] Bühlmann, H. and Gisler, A. (2005), *A Course in Credibility Theory and its Applications*, Springer [Outcome C1. A scanned version of Chapter 1 will be freely available on MyCourse.]
- [N] The Actuarial Education Company, *CT6 Combined Materials Pack*. [A subset of the course, which has the advantage of showing exactly what the Institute of Actuaries expects from students at CT6 exam, should you need to take the exam later. Note also that the syllabus can be downloaded for free]

All these references (except for the CT6 Combined Materials Pack) are available from the library. Should the quantity available be insufficient, please inform the course coordinator, who will forward this information to the library.

### **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 quizzes 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>.

### **Software**

This course will demonstrate many of its principles using the statistical language 'R'. R is freely available at <http://www.r-project.org/>.

### **Course WebCT Vista**

This course will use WebCT Vista for communication with students.

The WebCT Vista site for this course will contain the course outline, lecture notes, homework problems, 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 course in actuarial studies at UNSW is reviewed each session by the course coordinator using student evaluative feedback from UNSW's Course and Teaching Evaluation and Improvement (CATEI) Process. 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.

Based on comments of previous years' students, we have implemented the following changes:

- Changed of the order with which contents are covered
- Removal of some ruin theory contents
- Addition of contents on copulas
- Change of textbooks
- Increase support for R

In terms of course development, we have more clearly aligned the course activities and assessment tasks to its (newly defined) aims and learning outcomes. Also, a new website with a lot of information has been developed. The major assignment will be submitted using Turnitin and will be graded on-screen.

## **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.

Information and policies on these topics can be found in the 'A-Z Student Guide': <https://my.unsw.edu.au/student/atoz/ABC.html>. See, especially, information on 'Attendance and Absence', 'Academic Misconduct', 'Assessment Information', 'Examinations', 'Special Consideration', 'Student Responsibilities', 'Workload' and policies such as 'Occupational Health and Safety'.

### **8.1 Special Consideration and Supplementary Examinations**

UNSW policy and process for Special Consideration applies (see <https://my.unsw.edu.au/student/atoz/SpecialConsideration.html>). Specifically:

- Applications for special consideration (including supplementary examinations) must go through UNSW Central administration (within 3 working days of the assessment to which it refers) – applications will not be accepted by teaching staff;
- Applying for special consideration does not automatically mean that you will be granted additional assessment or that you will be awarded an amended result;
- If you are making an application for special consideration (through UNSW Central Administration) please notify your Course Coordinator or Lecturer in Charge;
- Please note: a register of applications for Special Consideration is maintained. History of previous applications for Special Consideration is taken into account when considering each case.

Students who believe that their performance in this course, either during session or in an examination, has been adversely affected by sickness, misadventure or other circumstances beyond their control may apply for special consideration for affected assessments. See the University web site for more details:

<http://www.student.unsw.edu.au/atoz/atoz-Special.shtml>

Students may be required to sit for an oral or written supplementary examination. Any supplementary examination date will be advised to students after the final examination. In general, a supplementary examination will only be offered to a student who has been prevented from taking the Final Examination who has been placed at a serious disadvantage during the examination, and whose circumstances have improved considerably in the period since the relevant examination was held. Failure to attend a supplementary examination, if you have been granted one, will result in forfeiture of any additional assessment granted to you. Satisfactory performance in any course assessment is required in order to be granted a supplementary examination.

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.

Further information concerning supplementary examinations is available on the 'Policies and Guidelines for Current Students' page of the ASB website:  
<http://www.business.unsw.edu.au/currentstudents>.

### **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.

### **8.2 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 that 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](http://www.my.unsw.edu.au)

### **8.3 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>.

## **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](mailto: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>.
- **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>
- **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>)  
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>)  
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

| Week Date      | LO                                                                    | Topics                                                                                                                         | Required Readings  | Optional Readings |
|----------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------|
| 1<br>21/07/09  | A1                                                                    | Convolutions of random variables                                                                                               | A: 2.1-2.3         |                   |
|                | A2                                                                    | Reinsurance (deductibles, policy limits, stop-loss premiums)                                                                   | A: 14.4            |                   |
| 26/07/09       | <i>Last day to enrol in Semester 2 courses</i>                        |                                                                                                                                |                    |                   |
| 2<br>28/07/09  | A1                                                                    | Convolutions of random sums and properties of compound distributions                                                           | A: 12.1-12.3       |                   |
|                | A1                                                                    | The compound Poisson process                                                                                                   | A: 12.4            |                   |
| 2/08/09        | <i>Due date for Semester 2 fees</i>                                   |                                                                                                                                |                    |                   |
| 3<br>4/08/09   | A1                                                                    | Panjer's recursion formula                                                                                                     | D                  |                   |
|                | A1                                                                    | Approximation methods                                                                                                          | A: 2.4, 12.5, 14.3 |                   |
| 4<br>11/08/09  | A3                                                                    | The Cramér-Lundberg surplus process                                                                                            | A: 13.1, 13.3      |                   |
|                | A4                                                                    | Probability of ruin: definition and coefficient of adjustment                                                                  | A: 13.4            |                   |
|                | A2                                                                    | Analysis of reinsurance using ruin theory                                                                                      | A: 14.5            |                   |
| 18/08/09       | <b>5.15pm - 6.05pm: Quiz 1 (venue to be confirmed later)</b>          |                                                                                                                                |                    |                   |
| 5<br>18/08/09  | B1                                                                    | Fitting: main principles and election of candidate distributions                                                               | E                  |                   |
|                | B2                                                                    | Estimation of parameters with complete or censored/truncated data                                                              |                    | B: 14             |
|                | B3                                                                    | Goodness-of-fit (GOF) tests                                                                                                    |                    |                   |
| 6<br>25/08/09  | B5                                                                    | Dependence structure between random variables                                                                                  | F, G               | (K: 5)            |
|                |                                                                       | Copulas: definition and properties                                                                                             |                    | K: 2.1-2.8        |
|                |                                                                       | Archimedean copulas                                                                                                            |                    | K: 4.1-4.3        |
|                |                                                                       | Random variate generation (simulation)                                                                                         |                    | K: 2.9            |
| 31/08/09       | <i>Last day for students to discontinue without financial penalty</i> |                                                                                                                                |                    |                   |
| 7<br>1/09/09   | B4                                                                    | GLM: Structure, assumptions and properties (stochastic and systematic components, link function)                               | H                  | L: 5              |
|                | B4                                                                    | GLM: Members of the exponential dispersion family                                                                              |                    |                   |
| 6/09/09        | <i>Last day to discontinue without academic penalty</i>               |                                                                                                                                |                    |                   |
| 8/09/09        | <i>No lecture: mid-semester break (5 September to 13 September)</i>   |                                                                                                                                |                    |                   |
| 8<br>15/09/09  | B4                                                                    | GLM: canonical models                                                                                                          | H                  | L: 5              |
|                | B4,E1                                                                 | GLM: use of R                                                                                                                  | B: 13, 15          |                   |
| 18/09/09       | <b>9.55am (sharp): assignment due in Turnitin box on WebCT</b>        |                                                                                                                                |                    |                   |
| 9<br>22/09/09  | C1                                                                    | Credibility methods: principles and motivation, model assumptions                                                              | M: 1               |                   |
|                | C1                                                                    | Bayesian estimation                                                                                                            |                    | M: 2              |
|                | C1                                                                    | Greatest accuracy credibility                                                                                                  |                    | M: 2              |
| 29/09/09       | <b>5.15pm - 6.05pm: Quiz 2 (venue to be confirmed later)</b>          |                                                                                                                                |                    |                   |
| 10<br>29/09/09 | C1                                                                    | Bühlmann model                                                                                                                 |                    | M: 3              |
|                | C1                                                                    | Bühlmann-Straub model                                                                                                          |                    | M: 4              |
| 11<br>6/10/09  | C2                                                                    | Motivation for reserving                                                                                                       | I: 1               |                   |
|                | C2                                                                    | Run-off triangles, adjustments for inflation and time value of money                                                           |                    |                   |
|                | C2                                                                    | IBNR techniques: chain ladder, arithmetic and geometric separation methods, Bornhütter-Ferguson, average cost per claim method |                    |                   |
| 12<br>13/10/09 | D1                                                                    | Elements of decision theory and decision rules                                                                                 | J                  |                   |
|                | D1                                                                    | Elements of game theory for two-person, zero-sum games                                                                         |                    |                   |
| 13<br>20/10/09 |                                                                       | Discussion of homework problems of week 12                                                                                     |                    |                   |
|                | All                                                                   | Questions and Answers                                                                                                          |                    |                   |

This timetable may be altered. Students will be advised of any changes in lectures and via the course web site. Detailed information about other learning activities (such as optional reading) and their suggested timing is available on the website.

## 11. MAJOR ASSIGNMENT

### 11.1 Learning outcomes

The particular aim of the assignment is to develop learning outcome E1, which can only be imperfectly assessed in an exam setting. It provides the opportunity to apply the concepts covered by the course to longer and more difficult tasks. It also aims at developing ASB Graduate Attributes 1, 2, 4, 5, and 6.

Question 1 focuses on the ASB Graduate Attributes 2, as well as 1, 4 and 5. It is also related to the course learning outcomes C2. It does not require any prior knowledge, and can be done at the beginning of the course.

Questions 2 and 3 concentrate on numerical applications, using R, on topics related to course aim A (risk and ruin theory) and learning outcome B5 (dependence modelling using copulas), respectively. The main focus is on learning outcome E1, for which half the marks for this part will be awarded. Interpretation and technical accuracy will attract the other half of the marks.

### 11.2 Assignment, Question 1

Your supervisor is preparing to give a lunchtime presentation on non-life claims reserving (improving on a strategic challenge) to students of a major Australian university involved in actuarial education. To help her prepare her presentation she has asked you to review (in 1200 words or less) the Swiss Re sigma publication 'Non-life claims reserving: Improving on a strategic challenge' (No 2/2008). She has specifically requested that you write the review in sentences and paragraphs, and not using bullet points.

### 11.3 Assignment, Question 2

Read the paper

- Dickson, D.C.M (1995), 'A review of Panjer's recursion formula and its applications', *British Actuarial Journal*, 1(1), pp.107–124.

Using R (and producing well documented code), clearly and carefully explain how the table appearing in example 2 of the paper is calculated.

Note that the computed value of  $\Psi(u)$  is an approximation, based on a crude rounding approximation of the distribution  $H$ . In applying the Panjer recursion formula to calculate this value, the discretised version of  $H$  has a mass of probability of  $H(0.025)$  at zero. Section 3 of the paper gives further references to the crude rounding approximation used.

### 11.4 Assignment, Question 3

The following algorithm generates random variates  $(u, v)$  from a Farlie-Gumbel-Morgenstern distribution with parameter  $\theta$ :

- Generate two independent uniform  $(0,1)$  variates  $u, t$ ;
- Set  $a = \theta(1 - 2u) - 1$ ,  $b = \sqrt{a^2 - 4(a + 1)t}$ ;
- Set  $v = 2t/(b - a)$ ;
- The desired pair is  $(u, v)$ .

In addition, the following algorithm generates random variates  $(u, v)$  from a Plackett distribution with parameter  $\theta$ :

- Generate two independent uniform  $(0,1)$  variates  $u, t$ ;
- Set  $a = c(1-t)$ ,  $b = \theta + a(\theta - 1)^2$ ,  $c = 2a(u\theta^2 + 1 - u) + \theta(1 - 2a)$ , and  $d = \sqrt{\theta} \sqrt{\theta + 4au(1-u)(1-\theta)^2}$ ;
- Set  $v = [c - (1 - 2t)d]/2b$ ;
- The desired pair is  $(u, v)$ .

It can also be shown that Spearman's  $\rho$  for a member of the Plackett family of copulas with parameter  $\theta > 0$  is given by

$$\rho_{\theta} = \frac{\theta + 1}{\theta - 1} - \frac{2\theta}{(\theta - 1)^2} \ln \theta.$$

Generate 1000 random variates  $(u, v)$  from a Plackett distribution with parameter  $\theta = 1$ . Use R to do this, carefully documenting your code. Calculate the corresponding pair of random variables  $(x, y)$  for a bivariate Pareto distribution; that is, with two Pareto marginals  $F_X(x)$  and  $F_Y(y)$ , each with parameters  $(2, 200)$ . Repeat this exercise for parameters  $\theta = 3$  and  $\theta = 20$ . Plot your six outcomes on one page (using R), with the first column containing the  $(u, v)$  results, and the second column containing the  $(x, y)$  results. The rows should contain ascending values of  $\theta$ .

Repeat the task outlined in the last paragraph, except now for random variates  $(u, v)$  from a Farlie-Gumbel-Morgenstern distribution; the values of  $\theta$  used should reflect an equivalent value of Spearman's  $\rho$  to the values of  $\theta$  of the previous paragraph.

Comment on your results.

### 11.5 Additional instructions and directions

Your R code used for Questions 2 and 3 must be provided in appendices at the end of your assignment. There should not be any output mixed with the code. The person marking the assignment must be able to copy and paste the code (without any editing) into the R GUI and readily reproduce your output—no further manipulation must be required. Thus, comments and explanations about the code must be correctly inserted in the code and not added once the code has been copied into the appendix.

Your assignment (Questions 1, 2 and 3, and the appendices – in that order) must be uploaded as a **unique pdf document** and all parts must be in **portrait format**. As long as the due date has not been reached, you can resubmit your work: the previous version of your assignment will be replaced by the new version.

You can create pdfs directly from any application of the Microsoft Office suite 2007. You need to install an official (free) add-in from Microsoft:

<http://www.microsoft.com/downloads/details.aspx?FamilyId=4D951911-3E7E-4AE6-B059-A2E79ED87041&displaylang=en>

The add-in is installed in the ASB computer labs. You can also save any other document as a pdf in the ASB computer labs by selecting "CutePDF Writer" from the list of printers and send a job to it. Several free applications exist to combine pdfs if you don't want to have everything in a single Word document, even though we recommend you do so.

Question 1 assesses your writing skills. To seek help about writing skills, please contact the ASB Education Development Unit (EDU), whose address you will find in Section 9 above.

Students are reminded that the work they submit must be their own (see section 5 above). While we have no problem with students working together on the assignment problems, the material students submit for assessment must be their own. This means that:

- The mathematical solutions you present are written up by you, without reference to any other student's work.
- Any R code you present are from your own computer, which you yourself developed, without any reference to any other student's work.

The students are advised that their assignment will be submitted via Turnitin, which 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/TurnItInStudentSupport.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, but won't have access to the originality reports.

### **11.6 Assignment submission procedure**

Assignments must be submitted via the Turnitin submission box that is available on the course WebCT Vista website.

**Please note that it is School policy that late assignments, even by one minute, will not be marked. Assignments MUST be submitted prior to the due time and date.** 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.

You need to check your document once it is submitted (check it on-screen). **We will not mark assignments that cannot be read on screen.**

Students are reminded of the risk that technical issues may delay or even prevent their submission (such as internet connection and/or computer breakdowns). Students should then consider either submitting their assignment from the university computer rooms or **allow enough time (at least 24 hours is recommended) between their submission and the due time.** The Turnitin module will not let you submit a late report. **No paper copy will be either accepted or graded.**

In case of a technical problem, the full document must be submitted to the course coordinator before the due time by e-mail, with explanations about why the student was not able to submit on time. In principle, this assignment will not be marked. It is only in exceptional circumstances where the assignment was submitted before the due time by e-mail that it may be marked—and the only if a valid reason is established.

### 11.7 Assessment criteria

| Question | Aims/<br>LO | ASB GA        | Criteria                                                                                                                   | Marks |
|----------|-------------|---------------|----------------------------------------------------------------------------------------------------------------------------|-------|
| 1        | C2          | 1, 2, 4, 5, 6 | The student summarised the main points of the document                                                                     | 10    |
|          |             | 2             | The student demonstrated good writing skills (organisation of the information, style, grammar, punctuation, spelling, ...) | 10    |
| 2        | A           | 1, 2, 5, 6    | Technical accuracy<br>(Details will be given after having graded the assignments)                                          | 20    |
|          | E1          | 1, 2, 5, 6    | The student has produced a correct and implementable R code for all the items of the question.                             | 8     |
|          | E1          | 1, 2, 5, 6    | The student documented the R code in a way that allows actuaries to understand it easily and quickly.                      | 8     |
|          | E1          | 1, 2, 5, 6    | The student has developed an R code that is efficient (the less code for the same functions, the more efficient)           | 4     |
| 3        | B5          | 1, 2, 5, 6    | Technical accuracy<br>(Details will be given after having graded the assignments)                                          | 20    |
|          | E1          | 1, 2, 5, 6    | The student has produced a correct and implementable R code for all the items of the question.                             | 8     |
|          | E1          | 1, 2, 5, 6    | The student documented the R code in a way that allows actuaries to understand it easily and quickly.                      | 8     |
|          | E1          | 1, 2, 5, 6    | The student has developed an R code that is efficient (the less code for the same functions, the more efficient)           | 4     |