



FACULTY OF  
BUSINESS AND ECONOMICS

ACST 356 / 861

Mathematical Theory of Risk

Semester 1, 2009

*Department of Actuarial Studies*

**MACQUARIE UNIVERSITY  
FACULTY OF BUSINESS AND ECONOMICS  
UNIT OUTLINE**

**ACST 356 / 861 Mathematical Theory of Risk  
FIRST SEMESTER 2009**

**Unit convenor: Jiwook Jang**

**Prerequisites:** (for ACST 356) STAT 272 (P)

**Corequisites:** (for ACST 861) STAT 810

Students in this unit should read this unit outline carefully at the start of semester. It contains important information about the unit. If anything in it is unclear, please consult the unit convenor.

**ABOUT THIS UNIT**

This 3 credit point unit examines the use of statistical models in the insurance context. Statistical models of the number of claims and the sizes of the claims are studied. These models are used as a basis for the study of risk theory, ruin theory and the effect of reinsurance. The use of no claim discount systems as a method of experience rating is described. Decision theory and simulation are also studied.

This unit relies heavily on your statistics studies (STAT 272 or STAT 810) and you should ensure that you revise this work if necessary. In particular, you should be familiar with:

- the theory of statistical distributions, including the meaning of a random variable, discrete and continuous random variables, density functions, cumulative density functions;
- basic results relating to expectation, variance, covariance, and moment and cumulant generating functions;
- joint random variables and marginal density functions;
- the use of Normal Distribution and Chi-Squared distribution tables;
- probability theory, including conditional probability; and
- some mathematical techniques and results including integration by parts and the binomial, logarithmic, exponential, and Taylor series approximations.

**TEACHING STAFF**

Leonie Tickle will be taking Week 1-4 lectures. Jiwook Jang (the unit convenor) will be taking Week 5-10 lectures. Michael Donovan will be taking Week 11-13 lectures

There is a teaching administrator for this unit, who is responsible for all the administrative aspects of the unit. Administrative questions *that are not covered in this unit outline* should be directed to the teaching administrator on the Private Mail facility of the website. (Instructions about how to do this will be provided in the first week of lectures). If the questions are of interest to everyone in the unit, the question and the reply will be posted to the Discussion Board, so you should specifically request if you want your message to remain private.

Questions about unit content should be sent to the Discussion Board of the website or raised during tutorials or lectures.

## CLASSES

Lectures are held Tuesday 2 pm – 4 pm in C5C T2 and Wednesday 11 am – 12 noon in E7B T5. There will be tutorial classes on Wednesday 12 noon – 1 pm and 1 pm – 2 pm, starting in week one. Any alterations to the class times or locations will be advised in lectures and via the website.

## CONSULTATION HOURS

There will be no consultation hours as questions about unit content should be initially posted on the Discussion Board of the website.

If face-to-face consultations for academic queries are required, students should contact to the staff member teaching that part of the course via the Macquarie University e-mail system to make an appointment.

Leonie Tickle will have face-to-face consultations until Wednesday 18 March in Week 4, after which Jiwook Jang (the unit convenor) will have face-to-face consultations including the part of the course taught by Leonie Tickle during Week 1-4. Michael Donovan will have face-to-face consultations during Week 11-13 on his part of the course.

## REQUIRED AND RECOMMENDED TEXTS AND/OR MATERIALS

### Required texts

Lecture handouts (ie. notes with gaps) are available for purchase from the Co-op bookshop. Complete notes including solutions to lecture exercises will be made available for downloading from the ACST356 website at the end of the lecture at which the relevant section of work is completed (eg. if we complete Section 1 at the end of week 2, the complete notes will become available at 2 pm Wednesday of week 2). This schedule is fixed and will not be varied for individual students unless the formal grounds for Special Consideration or Equity Support are met.

If you decide to purchase the optional texts (the ActEd CT6 notes and the Dickson text – see below), it is recommended that you read the relevant sections in advance of the lecture. During the lecture you can then work through the lecture handout, which will cover similar ground but expressed in a different way.

### Optional recommended text

- Dickson, D. (2005). *Insurance risk and ruin*. Cambridge University Press: Cambridge.

This book is available from the Macquarie University Co-op Bookshop. Copies are also available in the Reserve section of the library.

### Optional ActEd material

The ActEd CT6 are *not* set as required or recommended reading for this unit, since the unit notes are comprehensive and detailed. However, the ActEd CT6 notes will be set as a recommended reading for ACST357 / 862. If you plan to use them in ACST357 / 862 it may be useful to buy them now, at the start of the year, so that you can also use them as an additional reading for ACST356 / 861. Please contact ASSOC to arrange for purchase of the notes – they are not available from the Co-op bookshop.

Those who want to view a copy of the ActEd CT6 notes during the semester should contact the teaching assistant using Private Mail on the ACST356 / 861 website. Arrangements will be made for you to view them in the Department of Actuarial Studies. The notes are not available in the library. **This reference copy of the notes cannot under any circumstances be photocopied.**

### Other useful references

- Hossack, I.B., Pollard J.H, and Zehnwirth, B. (1999). *Introductory statistics with applications in general insurance*, second edition. Cambridge University Press: Cambridge.
- Klugman, S.A., Panjer, H.H, and Willmot, G.E. (2004). *Loss models: From data to decisions*, second edition. Wiley: New York.
- Casualty Actuarial Society. (2001). *Foundations of Casualty Actuarial Science*, 4<sup>th</sup> edition. Casualty Actuarial Society.

These texts are available in the library, with a single copy of each also available in the Reserve section of the library.

### UNIT WEB PAGE

Online Learning @ MQ now uses Blackboard CE6 for online units. You can access your online units from <http://learn.mq.edu.au/> or via the myMQ Student Portal. Your Online Learning @ MQ username will be your standard Macquarie Student ID Number (an 8-digit number found on your Campus Card) and you should use your myMQ Student Portal password for your CE6 online units.

Answers to frequently asked questions and help with login problems is available from <http://learn.mq.edu.au/> and from <http://online.mq.edu.au/docs/tecinf.html>. Before you use the website you should make sure that you are familiar with all of this information, including the Information Technology Security Policy and Rules and the Information Technology Usage Rules. The information also mentions a number of “plugins” that may be required. Of those listed, in this unit you will only need Acrobat Reader.

The website for this unit contains:

- **Course content:**
  - **Unit outline.** A copy of this unit outline.
  - **Unit notes.** Complete lecture notes for downloading each week.
  - **Assignments.** Assignments 1 and 2, and weekly revision quizzes (to be completed online).
  - **Mock tests.** Mock tests with solutions
  - **Tests and exams.** Past class tests and exams with solutions.
- **Assessments.** Online quizzes and assignments.
- **Discussions.** A Discussions board to discuss problems with your fellow students.
- **Mail.** To contact the teaching administrator and for the teaching administrator to contact you.

**It is your responsibility to check the website regularly to make sure that you are up-to-date with announcements and with messages sent to your Mail address.**

Remember to close your browser when you have finished using the site. If you don't, another person can use the still running browser to access the website with your account.

### LEARNING OBJECTIVES AND OUTCOMES

The learning objectives of this unit are summarised at the start of each section of work. You should revise these after each week to ensure that you understand them.

In addition to the discipline-based learning objectives, all academic programs at Macquarie seek to develop students' generic skills in a range of areas. One of the aims of this unit is that students develop their skills in the following: *Critical analysis skills; Problem-solving skills; Creative thinking skills.*

### TEACHING AND LEARNING STRATEGY

The unit material is covered in the three hours of lectures each week. The tutorial is an opportunity for you to attempt questions for each section of work, or to ask questions. A mock test will be run in the tutorial prior to each of the class tests. In addition to the tutorial, you should use the Discussion Board to ask questions or discuss concepts covered in the unit.

Week Number	Week Beginning	Lecture Topics	Due Mon 5 pm	Tutorial	Lecturer
1	23 February	1. Loss models	–	Tutorial	LT
2	2 March	Loss models (cont.)	Quiz 1	Tutorial	LT
3	9 March	2. Estimation and testing fit	Quiz 2	Tutorial	LT
4	16 March	Estimation and testing fit (cont.)	Quiz 3	Tutorial	LT
5	23 March	3. Credibility theory + 4. Reinsurance and deductibles	Quiz 4	Mock test	JJ
6	30 March	Test 1 + 4. Reinsurance and deductibles (cont.)	Quiz 5	Tutorial	JJ
7	6 April	5. Introduction to simulation	Quiz 6	Tutorial	JJ
<b>STUDY BREAK</b>	13 April 20 April		Ass 1		
8	27 April	6. Individual risk model	Quiz 7	Tutorial	JJ
9	4 May	7. Collective risk model	Ass 2	Tutorial	JJ
10	11 May	7. (cont.) + 8. Ruin theory	Quiz 8	Mock test	JJ
11	18 May	Test 2 + 9. Decision theory	Quiz 9	Tutorial	MD
12	25 May	Decision theory (cont.)	Quiz 10	Tutorial	MD
13	1 June	10. Rating; no claim discount	–	Tutorial	MD

#### RELATIONSHIP BETWEEN ASSESSMENT AND LEARNING OUTCOMES

There are two assignments in this unit, both to be made available under the Assignments section of the website and to be submitted online.

- Assignment 1 will involve fitting models to data for claim numbers and amounts, based on material covered in sections 1 and 2. It is due 5 pm Monday 20 April and is worth **5%** of the assessment for the unit.
- Assignment 2 involves simulating a total claims cost using the models developed in Assignment 1, based on the material covered in section 5. It is due 5 pm Monday 4 May and is worth **2%** of the assessment for this unit.

Although you may discuss general aspects of the assignments with other students, you will be required to certify that the assignments are all your own work, and to provide your detailed working immediately on request if required. Further details of the assignments will be provided in class.

#### Online Quizzes

To encourage you to revise the unit material regularly, I have set as part of the assessment a series of short online quizzes to be completed weekly. There are 10 quizzes in all, due at 5 pm each Monday according to the unit timetable above. The online quizzes are worth **8%** of the assessment in total.

#### Tests

Each test is worth 7.5% of the final assessment for the unit, total **15%**.

- Test 1 will be held Tuesday 31 March at 2 pm. It will cover Sections 1, 2 and 3.
- Test 2 will be held Tuesday 19 May at 2 pm. It will cover Sections 4, 5, 6 and 7.

A Formulae Sheet will be provided in the class tests. No other reference material is permitted.

You should contact the unit coordinator immediately (eg. prior to the test) if unexpected ill-health or other disruption affects your preparation for or performance in a class test. Applications for special consideration due to documented illness or unavoidable disruption must then be made on the "Advice of Absence or other Circumstances" form, available at <http://www.reg.mq.edu.au/academic-index.htm>, and submitted to the Student Enquiry Service on Level 1 of the Lincoln Building.

### **Exam**

The final examination (3 hours with 10 minutes reading time) is worth **70%** of the final assessment for the unit. A Formulae Sheet will be provided in the final exam. No other reference material is permitted. You should familiarise yourself with the information in the Formulae Sheet and its layout prior to the examination (a copy is provided at the start of the lecture notes).

The University Examination period in First Half Year 2009 is from 10 June to 26 June.

You are expected to present yourself for examination at the time and place designated in the University Examination Timetable. The timetable will be available in Draft form approximately eight weeks before the commencement of the examinations and in Final form approximately four weeks before the commencement of the examinations.

<http://www.timetables.mq.edu.au/exam>

The only exception to not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these circumstances you may wish to consider applying for Special Consideration. Information about unavoidable disruption and the special consideration process is available at <http://www.reg.mq.edu.au/Forms/APSCon.pdf>

If a Supplementary Examination is granted as a result of the Special Consideration process the examination will be scheduled after the conclusion of the official examination period. (Individual Faculties may wish to signal when the Faculties' Supplementary Exams are normally scheduled.)

You are advised that it is Macquarie University policy not to set early examinations for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, that is the final day of the official examination period.

### **Test and Examination Rules**

Normal examination rules apply to the conduct of tests and the final examination. These rules are set out under the heading "Conduct of Examinations" in the Student Information – Assessment section of the current Macquarie University Handbook of Undergraduate Studies. Students are responsible for familiarising themselves with these rules prior to the class tests and the final examination.

You should ensure that your handwriting in the class tests and in the final examination is legible. Sections of work that are not legible will not be marked.

Academic Senate has resolved that no mobile phones should be brought into examination rooms. Mobile phones must be switched off and sealed in closed bags during class tests.

Calculators will be allowed in the class tests and the final examination but a clear indication of the steps involved in every calculation must be shown. Any machines that have a text-retrieval capacity, whether or not they have a full alphabet on the keyboard, are not allowed. Calculators may be checked at the commencement of class tests and final exam, and the make/model may be recorded.

Dictionaries will not be permitted in the class tests or the final examination.

### **CLASS ETIQUETTE**

Mobile phones should be switched off during all lectures and tutorials. If there is an important reason for you to keep your phone on you should request to be allowed to do so before the start of the class.

Lectures commence at 5 minutes past the hour and you are expected to be punctual. You are expected to keep talking to a minimum so as not to disrupt your fellow students (and the lecturer!).

### **PLAGIARISM**

The University defines plagiarism in its rules: "Plagiarism involves using the work of another person and presenting it as one's own." Plagiarism is a serious breach of the University's rules and carries significant penalties. You must read the University's practices and procedures on plagiarism. These can be found in the *Handbook of Undergraduate Studies* or on the web at:

<http://www.student.mq.edu.au/plagiarism>

The policies and procedures explain what plagiarism is, how to avoid it, the procedures that will be taken in cases of suspected plagiarism, and the penalties if you are found guilty. Penalties may include a deduction of marks, failure in the unit, and/or referral to the University Discipline Committee.

### **UNIVERSITY POLICY ON GRADING**

Macquarie University uses the grades HD, D, Cr, P, PC and F for grading the achievements of students in units of study. The meaning of each symbol is explained in the Bachelor Degree Rules in the current Macquarie University Handbook of Undergraduate Studies. Your final result will include one of these grades plus a standardised numerical grade (SNG).

The numerical marks resulting from assessment of your work in this unit will be used as an initial indicator of the quality of your learning and understanding. The use of these numerical marks is, however, only a starting point in determining the appropriate grade. In particular, note that the SNG ranges mentioned in the Handbook of Undergraduate Studies are not the raw marks. To obtain a grade you must satisfy the qualitative definition of that grade. Once your grade has been determined, you are allocated an SNG indicating your approximate position amongst students assigned that grade.

Academic Senate has a set of guidelines on the distribution of grades across the range from fail to high distinction. It is important that you realise that the policy does not require that a minimum number of students are to be failed in any unit. In fact it does something like the opposite, in requiring examiners to explain their actions if more than 20% of students fail in a unit. For an explanation of the policy see <http://senate.mq.edu.au/rules/Guidelines2003.doc> or <http://senate.mq.edu.au/rules/detailedguidelines.doc>.

### **EXEMPTIONS**

The units ACST 356 / 861 and ACST357 / 862 together correspond to the professional subject CT6. The exemption will be recommended if and only if a SNG of at least 60 is achieved in both units and the average SNG is at least 65.

### **ELECTRONIC COMMUNICATION AND YOUR STUDENT FILE**

Every business keeps a record of its correspondence with its customers. The University is no exception and it maintains a file for every student. Staff are required to ensure that copies of all correspondence with you are added to your file. Historically, "correspondence" meant letters, but nowadays it also

includes electronic communication such as email. Staff have some discretion here and might not file copies of trivial emails, but it is difficult to define precise boundaries here, so it is safer to assume that any email you send to a staff member will be added to your file.

Some people regard email as more ephemeral than a letter and thus tend to take less care with issues such as clarity of expression, grammar and spelling. Before sending an email to a staff member, a good question to ask yourself is: "If a member of staff is reviewing my student file prior to writing a reference for me, and they see a copy of this email, would that staff member gain a favourable impression of my level of communication skills?"

In this context, email includes communications you send to staff with the mail tool in the unit's web site. It does not normally include postings you make to the discussion area. However, in those very rare cases where a student makes an inappropriate posting to the discussion area, a copy of the posting would be added to that student's file.

### **INSTITUTE OF ACTUARIES OF AUSTRALIA**

There are advantages to joining the Institute of Actuaries of Australia as a student. Please refer to <http://www.actuaries.asn.au/AboutTheInstitute/Membership> for information.

### **STUDENT SUPPORT SERVICES**

Macquarie University provides a range of Academic Student Support Services. Details of these services can be accessed at <http://www.student.mq.edu.au>.

**BESS.** The (Faculty of) Business and Economics Student Services (BESS) is located in room E4B106 and offers photocopying facilities, reading areas and reference material.

**ACSTINFO.** This ACSTINFO site is used to distribute information to all students majoring in actuarial studies. The information supplied may include administrative information and job advertisements. You will retain access to this site during the vacation following the end of this semester. It is to your advantage to ensure you read information on this web site regularly. You should not assume that information posted there will also be repeated in lectures. When you first access the site, please read the section labelled "How to use this site". This contains useful information that will help you determine when there is new information on the site that you should read.

### **FEEDBACK**

I would welcome your feedback on any aspect of the unit.

If you see that something could be improved, don't sit back and complain to your friends! Come and see me and let me know your ideas and if I agree that your ideas are good I will make changes. You can give me feedback in lectures or by posting to the website (anonymously if need be).

I have made significant changes to the unit in recent years in response to feedback, including changing the format of tutorials, introducing mock tests, introducing iLecture and introducing quizzes.

I hope not to see any feedback in the end-of-semester unit evaluations that I haven't heard about already and therefore had the opportunity to respond to. Please get involved in making this unit as useful and rewarding as possible.

Jiwook Jang  
18 February 2009