

**MACQUARIE UNIVERSITY**  
**Division of Economic & Financial Studies**  
**Department of Actuarial Studies**  
**ACST211 : Combinatorial Probability**  
**Unit Outline Second Semester 2008**

Unit convenor: Jim Farmer

Prerequisites: Admission to BCom – Actuarial Studies or associated double degrees. STAT171 with a grade of credit or better.

Corequisites: MATH133

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 one of the teaching staff in the unit.

### **1. About this unit**

Much of the work that actuaries do relates to the assessment and management of the financial consequences of risk. This analysis typically requires calculations involving probability. This unit is a study of probability, its nature and meaning, and a range of techniques for determining a numeric measure of the probability that a specific event will occur. The unit has a practical emphasis, focusing on applications of theory to evaluate probabilities of defined events.

Most of the examples encountered in this unit will not appear to be actuarial examples, since we deliberately adopt the clearest examples we can find to demonstrate concepts. However, most of the concepts we examine will be used in actuarial contexts in most of the 300-level ACST units.

### **2. Teaching Staff**

The unit convenor and lecturer, Jim Farmer, can be contacted via the unit's web site. Questions about the unit material should be placed in the Discussion Area. Administrative questions which have not already been answered in this document or the Student Guide should be sent to the "Administration Inquiries" account using the mail tool in the unit's web site.

Tutors cannot be contacted other than at tutorials.

### **3. Classes**

Class times can be found at: <http://www.timetables.mq.edu.au/>

### **4. Textbooks**

No textbooks are prescribed for this unit. It is recommended that you purchase the "Unit Notes", available from the Co-Op Bookshop.

### **5. Unit Web Page**

The unit web site can be accessed via the logon facility at <http://learn.mq.edu.au>

### **6. Unit Objectives – Learning Outcomes**

By the end of this unit you should:

- understand the fundamental concepts and principles of the range of probability approaches examined.
- be able to confidently apply those concepts and principles in determining probabilities for defined events and solving probability-based problems.
- be able to explain the concepts, principles and processes you are using, in clear, simple non-technical language, so that another student of the unit could follow your explanation.

- be able to clearly explain why a problem solution is correct (or not correct), so that another student of the unit could follow your explanation.
- have further developed your problem-solving skills.

Throughout the unit you should also be able to demonstrate ethical behaviour by complying with examination rules and assessment task rules, and by not colluding on assessment tasks.

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:

- Written communication skills; and
- Problem-solving skills.

## 7. Teaching and Learning Strategy

This unit is taught via lectures and tutorials. However, a significant amount of the lecture time will be spent on attempting problems. The emphasis is on learning by doing.

## 8. Assessment

In ACST211, quality of learning is interpreted in terms of **understanding**, which can be demonstrated by:

- applying concepts and principles to solve problems which are not necessarily of exactly the same type as problems encountered previously; and
- explaining, in clear, simple, non-technical language the concepts, processes and rationale behind the mathematical symbols.

The final examination will consist of 2 papers, each of 90 minutes duration with no reading time. The questions in the first paper of the final exam are short routine questions while those in the second paper allow you to demonstrate your deeper understanding. There are also online quizzes to complete.

In Step 1 of the grading process, the quizzes and paper 1 of the final exam will be used to subdivide students into the categories of 'Fail', 'Conceded Pass' and 'Pass or Better'.

In Step 2 of the grading process, the quizzes and both papers of the final examination will be used to subdivide students in the 'Pass or Better' category into 'High Distinction', 'Distinction', 'Credit' and 'Pass' categories. If Step 1 resulted in you being placed in the 'Pass or Better' category, you cannot be awarded a grade less than Pass in Step 2.

To earn a clear pass you need to demonstrate competence in solving the short routine problems encountered in the quizzes and Paper 1 of the exam. It may be possible to gain a Pass grade merely by memorising and reproducing the formulae and methods encountered in the lectures and tutorial exercises. To obtain a grade of credit or better you will need to demonstrate that you have come to terms with the **meaning** behind the mathematics by making progress on some of the problems in Paper 2 of the exam.

If you do not want a grade better than 'Pass', you need not attempt the second paper of the final examination.

The following table gives an indication of the relative weighting of the assessment components for the two steps of this process:

	Step 1	Step 2
Quizzes	10%	5%
Exam - Paper 1	90%	45%
Exam - Paper 2	–	50%

## 9. Student Support Services

Besides the general services available (see below), the Division of Economics and Financial Studies offers the following:

ERIC: EFS Resource and Information Centre. [http://www.efs.mq.edu.au/student\\_support/eric](http://www.efs.mq.edu.au/student_support/eric)

## 10. Weekly Table of Topics

Week Number	Week Beginning	Topic
1	4 August	1. Permutations
2	11 August	2. Combinations
3	18 August	3. Evaluating Probabilities by Enumeration of Cases
4	25 August	4. Probability Theorems
5	1 September	5a. Bayes' Theorem 5b. Generating Functions
6	8 September	6a. Linear Difference Equations 6b. Random Variables – Reading Topic
7	15 September	7. Expected Values
2 week study break		
8	6 October	9. Volumes by Double Integrals – Public holiday on Monday
9	13 October	8. Recursive Methods
10	20 October	10. Probabilities by Nested Integrals
11	27 October	11. Introduction to Markov Chains
12	3 November	12. Long Run Behaviour of Markov Chains
13	10 November	13. Revision

The order of topics 8 and 9 has been reversed to accommodate the lost lecture in week 8.

## 11. Detailed Topic List

Permutations (and related partitions): multiplication rule;  ${}^n P_r$ ; arranging distinguishable objects in a line; permutations of distinguishable objects with repetitions allowed; ordered partitions with distinguishable objects; permutations of a set of objects not all distinguishable; ordered partition of distinguishable objects with specified numbers for each cell.

Combinations (and related partitions):  ${}^n C_r$ ; combining separate cases; the “select, then permute” strategy; combinations with repetitions allowed; ordered partitions with identical objects; integer partitions.

Evaluating Probabilities by enumeration of cases: Identifying equally likely cases; possible outcomes and favourable outcomes; applications involving use of the permutations, combinations and partitions listed above.

Probability Theorems: Event notation; mutually exclusive events; conditional probability; the partition theorem; definitions for two or more independent events; multiplication rule for independent events.

Bayes' Theorem: Derivation; application; graphical methods of explaining non-intuitive results to non-mathematicians; multi-stage problems.

Generating Functions: Required power series expansions;  ${}^n C_r$  vs  $\binom{n}{r}$ ; application of generating functions to count partitions; development of probability generating functions; dice total problems.

Linear Difference Equations: first order homogeneous linear difference equations; first order difference equations with constant (non-zero) right hand side; second order homogeneous linear difference equations.

Random Variables: discrete and continuous; notation; converting between probability (density) functions and cumulative distribution functions; determining probabilities from probability (density) functions; definition of independent random variables.

Expected Values: Definitions for discrete and continuous random variables; expected value of a sum of random variables; efficient use of indicator random variables; expected trials till first success; geometric random variable and its mean.

Recursive methods: Application to games where two or more players take turns; application to series of games between two or more players; series of games terminated on obtaining a specified lead; series terminated by winning a specified number of games in a row; examples using the linear difference equations examined earlier; binary random walk problems with absorbing boundaries; application to probability of winning and to expected number of games till a win occurs.

Volumes by Double Integrals: Development of the concept of a double integral as the volume under a surface of the form  $z = f(x, y)$ ; evaluation of double integrals; verifying volume formula for some well-known solids.

Probabilities by nested integrals: Application of double integrals to probabilities of events involving two independent continuous random variables. Extension to triple integrals and three independent random variables for simple cases.

Time homogeneous finite state markov chains: transition probabilities; transition matrix; evaluating future probability vectors by multiplication by the transition matrix; the random variable interpretation of markov chains (briefly); Chapman-Kolmogorov Equation; transition graphs; definitions of accessible, communicate, class, irreducible, recurrent, transient, period, ergodic; recurrence, transience and periodicity are class properties; stationary distribution; long-run behaviour of ergodic markov chains; long-run behaviour of periodic irreducible markov chains; general strategies for analysing long-run behaviour of chains with more than one class.

## **IMPORTANT GENERAL REQUIREMENT FOR ALL UNITS**

### **12. EXAMINATIONS:**

The University Examination periods are from 11/6/08 to 27/6/08, and from 19/11/08 to 5/12/08. 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.

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.

No aids, other than a pen and pencil, may be brought into an exam *unless specifically permitted by the Convenor*. The following are expressly forbidden: mobile phones, calculators, computers, I-pods, PDAs, MP3s and any other electronic aid, and books.

### **13. PLAGIARISM AND CHEATING:**

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 Disciplinary Committee.

Plagiarism is simply a type of cheating. Any confirmed cheating may result in serious penalties, including deduction of marks, failure in the unit, and/or referral to the University Disciplinary Committee.

### **14. UNIVERSITY POLICY ON GRADING:**

Academic Senate has a set of guidelines on the distribution of grades across the range from fail to high distinction. Your final result will include one of these grades plus a standardized numerical grade (SNG).

Your raw mark for a unit (i.e., the total of your marks for each assessment item) is not the same as the SNG which you receive. Under the senate guidelines, results may be scaled to ensure that there is a degree of comparability across the university, so that units with the same past performance of their students should achieve similar results.

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.

The standard grading scheme is:

0 – 45	Fail
46 – 49	Pass Conceding*
50 – 64	Pass
65 – 74	Credit
75 – 84	Distinction
85 – 100	High Distinction

\* when this unit is not a prerequisite for later units.

### **15. 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>

### **16. CLASSROOM ETIQUETTE**

Students are expected to arrive on time, certainly before five minutes past the hour, and not to leave until the class ends. If you have a recurring problem that makes you late, or forces you to leave early, have the courtesy to discuss this with your lecturer/tutor.

Students are expected to be quiet during lectures unless, of course, class participation is required.

Mobiles should be turned off during classes; not simply set to “silent”.