

School of Mathematical Sciences
INTRODUCTION TO MATHEMATICAL STATISTICS II
Semester 1, 2004
NOTES FOR STUDENTS

GENERAL DESCRIPTION

Introduction to Mathematical Statistics II is a one-semester course which provides you with the mathematical foundations of modern statistical inference and applications. It is an important course for students who are planning further study in statistics or applied probability, or for students who need to use statistics in their chosen area of study, for example, engineering, economics or biological science. The emphasis throughout IMS II is on learning through explanations and problem solving, but essential formal mathematical theory is covered too.

Statistics is an important discipline in its own right. It is what is known as an *enabling discipline* for many fields of scientific work, including bioinformatics and finance. Statistics relies on mathematical knowledge (most notably probability theory, calculus and algebra), skills of synthesis and interpretation, and computational and communication skills.

UNITS VALUE: 2

PREREQUISITES AND ASSUMED KNOWLEDGE

There is a prerequisite of *either* Mathematics I *or* Mathematics IM. Those students who have done Mathematics IM would normally be concurrently enrolled in, or have already done, Mathematics IIM.

Most students will also have done Statistical Practice I *or* Mathematics for Information Technology I *or* Laplace Transforms and Probability and Statistics (LTPS, NAPS, Stat. Methods (Civil)). Students who have not done any of these courses will need to spend extra time on the first two chapters of the textbook over the first few weeks of this course.

RECOMMENDED CONCURRENT LEVEL II COURSES

If you are planning to Major in Statistics, you should also do the Semester 2 course *Statistical Theory and Modelling II* (2 units) in addition to Introduction to Mathematical Statistics II. We also strongly recommend that you take *Statistical Practice II* (2 units) as well, if you can fit the 6 Level II Statistics units into your undergraduate program.

You will find *Multivariable Calculus II* (2 units), and *Algebra II* (2 units) useful for mathematical statistics and the Statistics Major more generally.

STAFF

The Lecturer for this course is Associate Professor Patty Solomon, Room EM107 (Engineering Mathematics Building). Phone: 8303 3033, email: patty.solomon@adelaide.edu.au

The Tutor-in-Charge is Simon (Jono) Tuke, Room 204, level 2 of the Mathematics Building. Jono will post his office hours shortly.

LECTURES

The lectures will be held at 11.10am on Wednesdays and 10.10am on Fridays in Lecture Theatre G08 on the ground floor of the Mathematics Building.

Printed notes in the form of two lecture slides to a page will be handed out in the first lecture of Week 1.

TUTORIALS

Tutorials are held fortnightly in the *even-numbered weeks* starting in Week 2. We do expect you to have attempted the tutorial questions prior to your tutorial. Note that the Fortnightly Handouts (which are described below) contain the tutorial questions, the assignment questions to be handed in for marking, and additional exercises you may work through in your own time. Solutions to all tutorial and additional exercises will be provided.

Consult your timetable for the time and place of your allocated tutorial. Tutorial allocation lists, notices, exam results, etc, will be posted on the Statistics Notice-board outside Lecture Theatre G02 on the ground floor of the Mathematics Building. Spare copies of handouts etc will be available from the shelves outside Room G23a on the ground floor.

TEXTBOOK

The textbook for this course is

- *Mathematical Statistics with Applications*, 6th Edition (2002)

by Wackerley, Mendenhall & Scheaffer. Duxbury/Thomson Learning.

This book (hereafter known as WMS) will also be used in the other Level II Statistics courses this year and is a good investment if you are planning further studies in Statistics.

Copies are available from Unibooks (\$99.95 before discount). However, students get the 8% ETSS rebate plus the Unibooks discount which is 12% for cash for the first four weeks of semester. You may be able to obtain a copy of the 5th or 6th edition second-hand (the two editions are very similar). There are three copies of the textbook held on Reserve in the Barr Smith Library and one copy for normal loan. A solutions manual to the exercises in WMS is also held on Reserve.

You may find the following books useful further reading:

- *Mathematical Statistics and Data Analysis*, 2nd Edition (1995)

by J.A. Rice. Wadsworth.

A more extensive and slightly higher-level book. This is one of my favourite undergraduate statistics texts because of its emphasis on applications of realistic complexity. It is a hard book to learn from though because the mathematical details are fairly scant.

- *Probability* (1993) by J. Pitman. Springer-Verlag.

This book covers the material for the first two-thirds of the course. As the title implies, it is a book about basic probability for statistics. (I don't really recommend this one, but some people like it.)

- *Advanced Engineering Mathematics*, 8th Edition (1999)

by E. Kreyszig. John Wiley and Sons, Inc.

Students with an engineering background may already own this book, and it is useful for some of the material we will cover in IMS II.

FORTNIGHTLY HANDOUTS

At the beginning of each fortnight (in the odd weeks) you will receive a handout which contains an outline the topics to be covered during the following fortnight, together with the relevant sections of the lecture notes and the textbook. The handout will also contain the tutorial and assignment questions, and any important announcements.

CONSULTING TIMES

These will be announced shortly.

ASSIGNMENTS

There will be **three assignments, due by 10am on Fridays in Weeks 5, 8 and 12**. The pooled mark for the three assignments will count 20% towards the final assessment. As explained below (see Examination), if your final mark based on the examination alone is higher than your combined assignment plus examination mark, then the higher final mark will be awarded, and vice versa.

Please note that unless negotiated prior to the due date, or other arrangement, late assignments will attract a 20% penalty per day.

Your assignments should be placed in the boxes marked 'Level II Statistics' on the ground floor of the Mathematics Building in the stairwell opposite Room G03. The front of your assignment should include your name and Tutorial time. We will make every effort to mark and return your assignments within a fortnight of the due date. Solutions to the assignments will be provided.

EXAMINATION

There will be a **closed-book two-hour examination** at the end of this course in the June examination period, comprising 80% of the final mark. *However, if your final mark is higher using the examination result alone, then this will be 100% of your final mark.* The exam will be based on the material covered in the lectures, assignments, tutorials and other exercises.

Statistical formulae and tables required in the exam will be provided. Past exam papers and attachments are available from my home page <http://www.maths.adelaide.edu.au/people/psolomon/teaching.html>

The supplementary examination will be held in July 2004. Students should refer to the School Policy on supplementary examinations.

WHO SHOULD BE DOING THIS COURSE

Introduction to Mathematical Statistics II is essential for any student who is planning one or more of the following:

- A career in statistics or applied probability, including government, banking, bioinformatics, biostatistics or telecommunications.

- A career in a discipline which uses high-level applications of statistics, for example, finance, computer science or engineering.
- To do the Statistics Major.
- To enrol in one or both of the core third year Statistics courses Statistical Modelling III and Theory of Statistics III.
- To enrol in one or more of the elective Level III Statistics courses. In 2004, the mainstream Statistics electives are *Time Series III*, *Biostatistics III*, *Statistics for Quality Improvement III* and *Sampling Theory and Practice III*.
- To apply for an Australian Bureau of Statistics Undergraduate Scholarship in Statistics.

COURSE OUTLINE

- 1. Introduction:** What Statistics is about and why it is important. Illustrative examples.
- 2. Probability:** Probability theory needed for mathematical statistics (notation and axioms); sample spaces, events, equally likely outcomes. Chance odds and odds ratios. The relative frequency and Bayesian interpretations of probability. Conditional probability and independence. An introduction to named and empirical distributions. Sequences of events. Bayes' Rule and Bayes' Odds.
- 3. Discrete random variables:** Expected values, and expectations of functions of random variables. The Bernoulli and geometric distributions. Random sampling with and without replacement leading to the binomial and hypergeometric distributions. Normal approximation to binomial. The Poisson distribution. Moment generating functions. Markov's Inequality and Tchebyshev's Inequality.
- 4. Continuous distributions:** The cumulative distribution function and probability density functions. Expectation. The continuous uniform, normal and Cauchy distributions. The exponential distribution, the hazard and survival functions, and half-life. Poisson processes. Gamma and chi-square distributions. Moment generating functions. Tchebyshev's Inequality.
- 5. Multivariate probability distributions:** Bivariate and multivariate distributions for discrete and continuous random variables. Marginal and conditional distributions. Independence. Expected values. Covariance and correlation. Moments for linear combinations of random variables. The multinomial distribution.
- 6. Functions of random variables:** The three different methods for finding the distribution of a function of random variables: distribution functions (i.e., the cdf method), transformations, and moment generating functions.
- 7. Appendix of additional topics in case they are useful to you (this material is not examinable):** The bivariate normal distribution. Conditional expectation.

A note for engineering students who have done LTPS, etc:

Engineering students who have done Probability and Statistics for Engineers II have to an extent already covered most *although not all* the material in Chapters 1 and 2, Chapter 3 up to Section 3.9, and Chapter 4 up to Section 4.9. I expect to move quite quickly through these sections. However, if you did well in the PS component of LTPS, you may wish to revise this material in your own time. Please note though that you are required to complete *all* tutorial exercises and assignments. Note too that the rest of Chapters 3 and 4 and Chapters 5 and 6 contain new material for you, as does the Appendix, which all students find challenging and many find difficult. You therefore are strongly recommended to attend the relevant lectures and tutorials.

Everyone:

The lecture notes, Fortnightly Handouts and any additional handouts for this course will be available from MyUni at <http://www.myuni.adelaide.edu.au> or from my web page at <http://www.maths.adelaide.edu.au/people/psolomon/teaching.html>. Paper copies of all handouts will be provided free of charge.

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Associate Professor Patty Solomon

20 February 2004