

2291ENV

Experimental Design and Statistics

Semester 1 - 2008

Academic Organisation:	Griffith School of Environment
Faculty:	Science, Environment, Engineering and Technology
Credit point value:	10
Student Contribution Band:	Band 2
Course level:	Undergraduate
Campus/Location/Learning Mode:	Nathan / On Campus / In Person
Convenor/s:	Mr James McBroom (Nathan)
Enrolment Restrictions:	Nil
This document was last updated:	17 February 2008

BRIEF COURSE DESCRIPTION

Environmental research typically involves the collection of data and subsequent statistical analysis. Good research which enables valid conclusions, requires consideration of experimental design and appropriate statistical analysis. This course presents the basic principles of experimental design together with a range of commonly used statistical methods. Through the completion of a project, students experience all aspects of the quantitative process from question definition and initial exploratory data analysis, through formal statistical inference, its interpretation in terms of an original research question, and the implications of underlying assumptions and resulting limitations. The use of commercial statistical software enables real experiences of data management and analysis.

Incompatible: AES2121 Research and Statistical Methods; 2204EAS Applied Statistics; 2291AES Experimental Design & Statistics

Advised Prerequisite: 1171AES Statistics for the Environment; OR 1101AES Statistics and Data Management

SECTION A – TEACHING, LEARNING AND ASSESSMENT

COURSE

AIMS

Course Aims

Most research in environmental studies involves the collection of data and subsequent statistical analysis. Good research leading to valid conclusions requires consideration of experimental design. By drawing on real research situations, this course exposes the student to a range of designs and statistical techniques within an applied context, and enables students to experience the real issues that arise from underlying assumptions and limitations.

This course covers the principles behind designing experiments, and extends the range of statistical methods available for data analysis. Study of statistical models and associated inferential techniques, provides the skills and understanding necessary for valid analysis and interpretation of empirical studies.

The main aim of this course is to provide students with a learning environment in which they will:

- develop skills in basic research methodology and experimental design;
- become familiar with a variety of quantitative methods used in research;
- gain expertise in using a variety of quantitative techniques;
- become competent at interpreting results from, and recognising the limitations of, the analytic methods encountered;
- develop skills and confidence in selecting appropriate methodology for a variety of research questions;
- develop skills and confidence in using statistical software and associated data management.

LEARNING

OUTCOMES

At the end of this course students should have acquired the following.

1. The ability and confidence to apply exploratory data analysis in an effective and informative manner.
2. The ability to use parametric, nonparametric and resampling statistical methods to carry out tests of hypotheses and estimation relating to means, medians, proportions and distributions from a range of statistical models including factorial, loglinear, multiple and polynomial regression and covariate.
3. An understanding of the basic multivariate techniques used in classification and ordination.
4. An appreciation of the need for sound research methodology and the roles played by the scientific method and experimental design.
5. An awareness that all statistical analyses have underlying assumptions which place limitations on the interpretations and subsequent conclusions.
6. Knowledge of and confidence in using the statistical software SAS to carry out a variety of exploratory data analyses and inferential statistics.
7. The ability to analyse a problem presented in words, to identify: the questions to be answered, the variables to be measured, an appropriate experimental design, and the relevant statistical analyses and associated limitations.
8. The ability to interpret statistical analyses and present a clearly written conclusion which relates to the question at issue.

CONTENT,

ORGANISATION

AND

TEACHING

STRATEGIES

Lectures

Students will receive lectures that introduce the required material and provide examples and guidance for applying newly learned techniques. Lectures will be supported by the written material provided in the Lecture Manual. Additional material will be provided in lectures which involve interactive activities, and students will be expected to add to the manual, the material provided and learned during lectures.

Students who do not attend lectures will be at a disadvantage. This combined material acquired from the Lecture Manual and from the lectures through hand outs and notes, together with referenced sections of the textbook, will provide the guidance students need to carry out examples on their own during workshops and in their own time.

Workshops

The workshops provide an important component of the learning process, in which students have the opportunity to practise the statistical methods they are learning in lectures, under the guidance of tutors. All workshops will be carried out in computer laboratories and students will be required to use the computers for the implementation of the statistical software, SAS. Examples used in workshops will come from a range of real research in the environmental sciences. Time will also be made available in workshops for students to work on their group project which provides a major component of the assessment. Attendance at all workshops is expected and will be recorded by each student's personal tutor who will review progress on the project on a weekly basis.

Course Web Site

The course website can be found at www.ens.gu.edu.au/stats. This website contains all details of the projects and their datasets, workshops, SAS help, assessment and feedback, and additional information. Students need to check the *Latest News* section regularly for messages from the convenor.

Contact Summary

Lectures: Three hours per week – a one-hour and a two-hour session.

Workshops: One two-hour session each week

Students are expected to attend all lectures and workshops.

CONTENT

SUMMARY

The content will include a range of statistical methods most of which will be applicable in the student project. However, it will **not** be expected that techniques covered later in the course will form part of the project.

Week	Lecture Content	Workshop Content	Assessment Activities
1.	Introduction & Revision – Problem Definition Revision – Experimental Design, CR & Statistical Models Revision - SAS	None	
2.	Factorial Models – Crossed Factors Interpreting the Factorial Factorial ANOVA on SAS	Group Formation Revision of SAS	Project Selection
3.	Multiple Treatment Comparisons – Protected t , Tukey's HSD Multiple Treatment Comparisons – SNK, Bonferroni Experimental Design – Randomised Complete Blocks, RCB	Factorial ANOVA Revision of SAS	Project Question Selection
4.	Assumptions underlying the ANOVA, Transformations Nonparametric Techniques 1	Multiple Treatment Comparisons	

Week	Lecture Content	Workshop Content	Assessment Activities
	Nonparametric Techniques 2	RCB Designs	
5.	Nonparametric Techniques 3 <i>Exam</i> <i>Exam</i>	Revision Nonparametric Techniques	Midsemester Exam Weight 15%
6.	Nonparametric Techniques 4 Multivariate Data – Covariance, Correlation, Causation, Analysis of Covariance Complex Statistical Models – Interpretation & Inference	Nonparametric Techniques	Project Phase 1 Due Weight: 10%
7.	Multiple Regression 1 <i>Good Friday</i>	Correlation, Regression and Covariance	Project Phase 1 Returned
8.	Multiple Regression 2 Multiple Regression 3 - Diagnostics Multiple Regression 4 – Diagnostics & Insight	Consolidation Project Questions	Project Phase 2 Due Weight: 15%
9.	<i>Labour Day</i> Contingency Tables – The Chi-squared (χ^2) Test of Independence Loglinear Models 1	Multiple Regression	Project Phase 2 Returned
10.	Loglinear Models 2 Multivariate Methods 1 – Introduction to Classification Multivariate Methods 2 – Introduction to Ordination	Contingency Tables	
11.	Statistical Distributions 1 Statistical Distributions 2 Goodness of Fit 1 – Chi-squared (χ^2)	Loglinear Models	Project Final Report Due Weight: 20%
12.	Goodness of Fit 2 – Other tests of fit Sample Size, Power and Statistical Inference Resampling Methods – Permutation Tests & Bootstrapping	Statistical Distributions Goodness of Fit	
13.	The Bayesian Statistical Paradigm Simple Bayesian Inference Statistics in Research & Revision	Bootstrapping Revision	

ASSESSMENT

Summary of Assessment

Item	Assessment Task	Length	Weighting	Total Marks	Relevant Learning Outcomes	Due Day and Time
1.	Mid Semester Examination	90 minutes	15%	15	2, 4, 5, 7	Friday Week 5,

2.	Project Phase 1	250 words	10%	10	1, 4, 7	Workshop Week 6
3.	Project Phase 2	500 words	15%	15	2, 4, 5, 6, 7, 8	Workshop Week 8
4.	Project Final Report	3000 words + figures etc	20%	20	1, 2, 4, 5, 6, 7, 8	Friday Week 11, 5pm
5.	Final Examination	3 hours + 10 minutes perusal	40%	40	2, 3, 4, 5, 7, 8	Exam Period

Note that although students work in groups and group interaction is required, all project submissions are individual student reports.

Assessment Details

Project

The project provides an opportunity for students to experience a real research situation in which they must identify the overall research question, locate the research within the relevant literature, select appropriate specific questions, choose statistical methods that will address these questions using both exploratory data analysis and statistical inference, carry out analysis using statistical software, provide a written interpretation, and relate their findings back to the original questions of interest. This process must be done within a group situation where other students' results form a component of each student's individual report.

For the Phase 1 report, each student will select a project, identify clearly the problem at issue, carry out a literature search to set the problem within its research context, complete initial exploratory data analyses and select specific questions that they will answer.

Phase 2 of the project serves to ensure, (a) that students have carried out suitable analyses, and (b) that all students have access to sensible results from other members within their group for inclusion in their final report. The latter aim is obtained by moderation by teaching staff of the second phase submissions.

In the final report, students must put together the full set of tasks that are needed to achieve a sensible interpretation of the available data within the context of the questions posed.

Note that although students work in groups and group interaction is required, all project submissions are **individual** student reports.

A detailed statement of what is required for each section will be handed out to students two weeks before the submission date.

Examinations – Mid Semester and Final

The examinations provide a venue for assessing the students' skills at problem solving, experimental design, and data analysis and interpretation using a range of statistical techniques. Both examinations are closed book, however, it is not intended that students learn large numbers of formulae, and a full set of tables and formulae are provided in the examination. An identical set is used throughout the course so students are familiar with what will be given to them during the examination. The content of these formulae is refined in consultation with students during lectures.

Marking Criteria

Project Written Reports

Individual submissions will be assessed on the following criteria: definition of problem, appropriateness of solution to problem, correctness of solution to problem, justification of solution including clarity of argument, understanding of problem and solution, clarity of explanation, clarity of expression, cohesiveness of material, and clarity of presentation.

Examinations

A detailed marking scheme will be developed for each question and will be based on the following criteria: appropriateness of solution including the approach selected, progressive working and reasoning as the solution progresses, correctness of final result and/or conclusion, justification of process, and validity of argument.

Return of Assessment Items

Written feedback will be provided on the hard copy reports submitted by students. For Phases 1 and 2 of the project, this will be returned to students during their workshops in the week following their submission. The final report with written comments will be available to students the week prior to the final examination.

Detailed feedback will be provided on the Mid Semester Examination during the lectures in Week 7 and on the course web page.

Distributions of progressive marks will be available on the web page.

Notification of Availability of Feedback on Assessment

See details in previous section. Students should check the *Late News* section of the course web page (www.ens.gu.edu.au/stats), for any variations in the proposed assessment return schedule.

GRADUATE

SKILLS

Graduate Skills	Taught	Practised	Assessed
Effective communication (written)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Effective communication (oral)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Effective communication (interpersonal)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Information literacy	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Problem solving	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Critical evaluation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Work autonomously	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Work in teams	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Creativity and innovation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Ethical behaviour in social / professional / work environments	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Responsible, effective citizenship	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

TEACHING

TEAM

Course Convenor

Convenor Details	Nathan
Campus Convenor	James McBroom

Email	J.McBroom@griffith.edu.au
Office Location	N55 2.11
Phone	3735 6677
Fax	
Consultation times	See <i>Late News</i> section of course web page: www.ens.gu.edu.au

Additional teaching team members

Part Time Tutors – to be advised

COURSE

COMMUNICATIONS

The course is delivered through weekly lectures and workshops. Each student will have a personal tutor during workshops and this should be the first point of contact. Students are expected to attend all lectures and workshops, and all lectures will have an interactive component which will allow for communication with the convenor. The course web site has comprehensive additional material and a *Late News* section which is regularly updated with announcements – students should ensure that they read this weekly. Emails to the convenor will be answered within two days in most cases.

TEXTS

AND

SUPPORTING

MATERIALS

Prescribed Texts:

Biostatistical Analysis 4th Edition by Jerome H. Zar (1999), Prentice-Hall, London.

Lecture Manual for 2291AES 2006 – available from the bookshop

(Note that students will be required to add to the material in their Lecture Manual from lectures.)

Additional information will be available on the course web page: www.ens.gu.edu.au/stats.

Recommended Reading

P.V. Rao (1998) *Statistical Research Methods in the Life Sciences*, Duxbury.

Douglas G. Montgomery (1997) *Design and Analysis of Experiments*, John Wiley & Sons Inc. USA.

David S. Moore and George P. McCabe (2003) *Introduction to the Practice of Statistics 4th Edition*, W.H. Freeman & Company, New York, USA.

Michael J. Evans (2000) *SAS[®] Manual for Moore and McCabe's Introduction to the Practice of Statistics 3rd Edition*, W.H. Freeman & Company, New York, USA

Software

Students may obtain from the library, copies of SAS for installation on their own computers – the appropriate form is required.

SECTION

B

–

ADDITIONAL

COURSE

INFORMATION

Students should refer to the Learning@Griffith website and to the course web page (www.ens.gu.edu.au/stats) for further information about this course.

ADMINISTRATION

1. Assessment items must be submitted to Off-Campus and Assignment Handling Services, or by post if prior agreement of course convenor has been obtained, but **not** by facsimile.

2. If students wish to submit assessment items with any similar material for two or more courses, they must first seek approval of all course convenors. Failure to do so could be interpreted as cheating.
3. Students should note that submission of an assignment represents an affirmation that it is **all their own work** and that **nothing has been copied** from the work of others **except where appropriately referenced**. The Griffith University *Policy on Academic Misconduct* lists examples of plagiarism under item 2.0, pages 1-2. These are:
 - “word for word copying of sentences or paragraphs from one or more sources which are the work or data of other persons (including books, articles, theses, unpublished works, working papers, seminar and conference papers, internal reports, lecture notes or tapes) without clearly identifying their origin by appropriate referencing” (Note: Appropriate referencing means using quotation marks and providing precise details as to the location of the original, e.g. page number(s));
 - “closely paraphrasing sentences or paragraphs from one or more sources without appropriate acknowledgment in the form of a reference to the original work or works” (Note: This means providing page numbers or other detailed location information);
 - “using another person’s ideas, work or research data without appropriate acknowledgment”;
 - “submitting work which has been produced by someone else on the student’s behalf as if it were the work of the student”;
 - “copying computer files in whole or in part without indicating their origin”;
 - “submitting work which has been wholly or partially derived from another student’s work by a process of mechanical transformation; for example, changing variable names in computer programs”.
4. Late Penalties: The penalty for late submission of assessment items is 10% of the total assessment mark for the item per day, unless otherwise specified in the course outline. No assignments will be accepted after the one-week period. A Special Consideration form must be completed and submitted to the Student Administration Office if students request waiver of the late penalty or an extension to an assessment item. Extensions **may** be granted for medical conditions, however extensions will not be granted for work commitments, family commitments or computer failure.
5. Special Consideration: Students applying for special consideration (due to medical or other grounds) for assessment items must complete the appropriate application form **available from a Student Administration Centre**. Special consideration is not retrospective and students should submit Special Consideration forms as soon as they experience any difficulties which may interfere with study or examination performance. It is expected that any applications for special consideration will be received within three days after the date of examination.
6. Enrolment in this course is granted on the basis that a grade of "P" (Pass) or better has been achieved in any prerequisite or assumed-prior-knowledge course, as specified in Section 1 of this course outline. Failure to meet this requirement may result in your having difficulty with the course and not being able to complete it successfully. Any additional support or special assistance cannot be expected or requested if the prerequisite is waived, or if prior-knowledge requirements have not been met.

SECTION C – KEY UNIVERSITY INFORMATION

ACADEMIC MISCONDUCT

Students must conduct their studies at the University honestly, ethically and in accordance with accepted standards of academic conduct. Any form of academic conduct that is contrary to these standards is academic misconduct and is unacceptable.

Some students engage deliberately in academic misconduct, with intent to deceive. This conscious, pre-mediated form of cheating is one of the worst forms of fraudulent academic behaviour, for which the University has zero tolerance and for which penalties, including exclusion from the University, will be applied.

However the University recognises many students commit academic misconduct without intent to deceive. These students may be required to undertake additional educational activities to remediate their behaviour.

Specifically it is academic misconduct for a student to:

- **Cheat in examinations and tests** by communicating, or attempting to communicate, with a fellow individual who is neither an invigilator or member of staff; by copying, or attempting to copy from a fellow candidate; attempting to introduce or consult during the examination, any unauthorised printed or written material, or electronic calculating or information storage device; or mobile phones or other communication device, or impersonates another.
- **Fabricate results** by claiming to have carried out tests, experiments or observations that have not taken place or by presenting results not supported by the evidence with the object of obtaining an unfair advantage.
- **Misrepresent themselves** by presenting an untrue statement or not disclosing where there is a duty to disclose in order to create a false appearance or identity.
- **Plagiarise** by representing the work of another as their own original work, without appropriate acknowledgement of the author or the source. This category of cheating includes the following:
 1. collusion, where a piece of work prepared by a group is represented as if it were the student's own;
 2. acquiring or commissioning a piece of work, which is not his/her own and representing it as if it were, by
 - purchasing a paper from a commercial service, including internet sites, whether pre-written or specially prepared for the student concerned
 - submitting a paper written by another person, either by a fellow student or a person who is not a member of the University;
 3. duplication of the same or almost identical work for more than one assessment item;
 4. copying ideas, concepts, research data, images, sounds or text;
 5. paraphrasing a paper from a source text, whether in manuscript, printed or electronic form, without appropriate acknowledgement;
 6. cutting or pasting statements from multiple sources or piecing together work of others and representing them as original work;
 7. submitting, as one own work, all or part of another student's work, even with the student's knowledge or consent.

A student who willingly assists another student to plagiarise (for example by willingly giving them their own work to copy from) is also breaching academic integrity, and may be subject to disciplinary action.

Visit the University's Institutional Framework for Promoting Academic Integrity Among Students for further details.

PLAGIARISM DETECTION SOFTWARE

From semester 2, 2007 the University has been piloting the use of plagiarism detection software. Students should be aware that your Course Convenor may use this software to check submitted assignments. If this course is included in the pilot your Course Convenor will provide more detailed information about how the detection software will be used.

HEALTH AND SAFETY

Griffith University is committed to providing a safe work and study environment, however all students, staff and visitors have an obligation to ensure the safety of themselves and those whose safety may be affected by their actions. Staff in control of learning activities will ensure as far as reasonably practical, that those activities are safe and that all safety obligations are being met. Students are required to comply with all safety instructions and are requested to report safety concerns to the University.

General health and safety information can be obtained from http://www.griffith.edu.au/hrm/health_and_safety/

Information about Laboratory safety can be obtained from http://www.griffith.edu.au/ots/secure/health/content_labsafety.html

KEY STUDENT-RELATED POLICIES

All University policy documents are accessible to students via the University's Policy Library website at: www.griffith.edu.au/policylibrary. Links to key policy documents are included below for easy reference:

[Student Charter](#)

[Academic Standing, Progression and Exclusion Policy](#)

[Student Administration Policy](#)

[Policy on Student Grievances and Appeals](#)

[Assessment Policy](#)

[Examinations Timetabling Policy and Procedures](#)

[Academic Calendar](#)

[Guideline on Student E-Mail](#)

[Health and Safety Policy](#)

UNIVERSITY SUPPORT RESOURCES

The University provides many facilities and support services to assist students in their studies. Links to information about University support resources available to students are included below for easy reference:

[Learning Centres](#) - the University provides access to common use computing facilities for educational purposes. For details visit www.griffith.edu.au/cuse

[Learning@Griffith](#) - there is a dedicated website for this course via the Learning@Griffith student portal.

[Student Services](#) facilitate student access to and success at their academic studies. Student Services includes: Careers and Employment Service; Chaplaincy; Counselling Service; Health Service; Student Equity Services (incorporating the Disabilities Service); and the Welfare Office.

[Learning Services](#) within the Division of Information Services provides learning support in three skill areas: computing skills; library skills; and academic skills. The study skills resources on the website include self-help tasks focusing on critical thinking, exam skills, note taking, preparing presentations, referencing, writing, proof reading, and time management.
