Mathematics and Statistics | Lancaster University

Lancaster University
Faculty of Science and Technology
Department of Mathematics and Statistics

QUANTITATIVE METHODS FOR SCIENCE, SOCIAL SCIENCE AND MEDICINE

POSTGRADUATE DEGREE COURSE PROGRAMME 2016-2017

Postgraduate Statistics Centre

CONTENTS

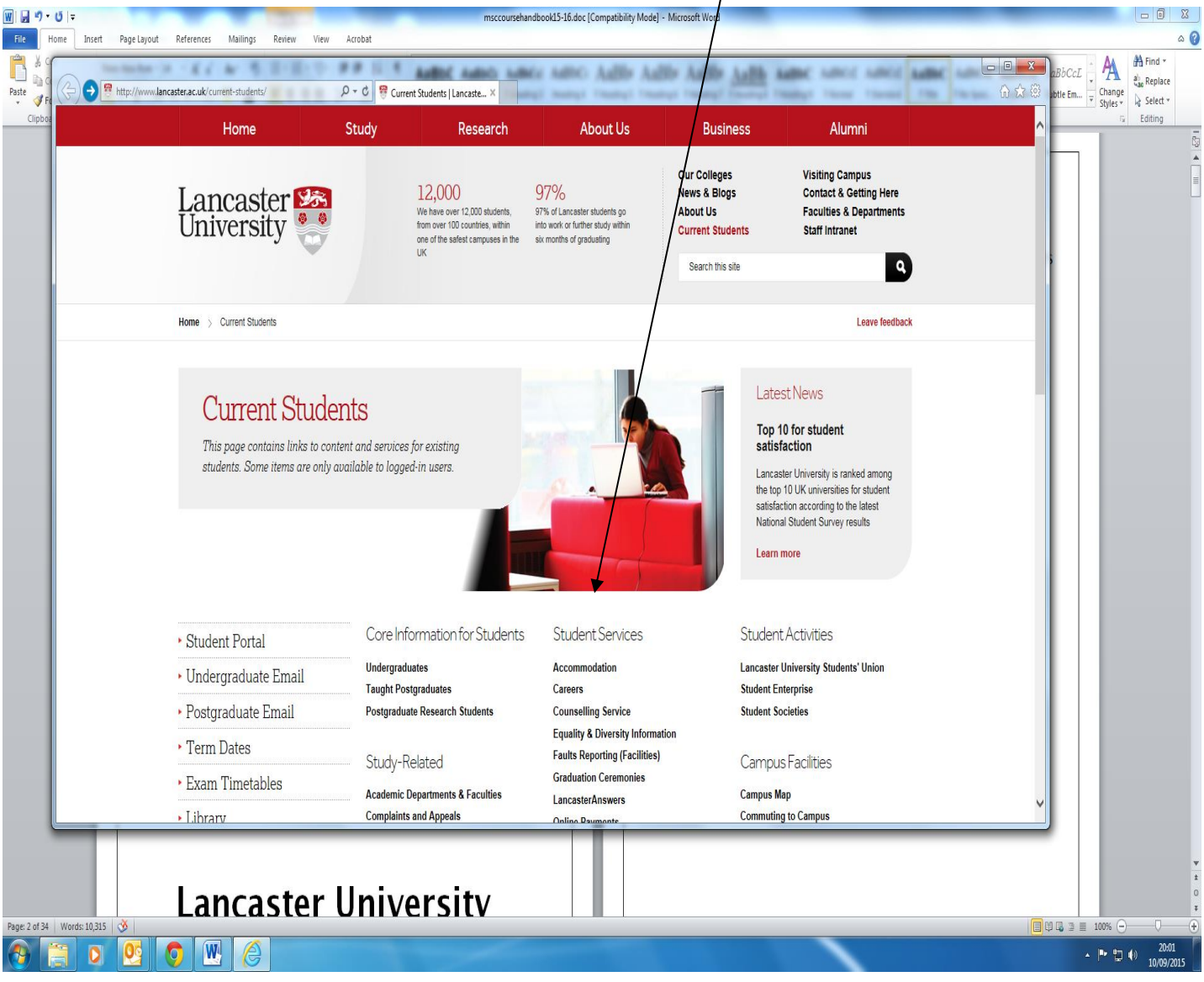
Core Information for Lancaster University PG Students

This course handbook has been compiled to assist MSc Data Science students studying at Lancaster University. More generally, all core university-level postgraduate information is available from the web page:

http://www.lancaster.ac.uk/current-students/

and can be accessed from 'Core Information for Students' categorised under the respective student groupings:

Taught Postgraduate Core Information



1 Introduction

This booklet contains details of the Master of Science (MSc) programme in Quantitative Methods for Science, Social Science and Medicine. The Postgraduate Diploma (PgDip) and Postgraduate Certificate (PgCert) are alternative programmes that are available to those who do not wish to complete the whole MSc programme but who would like to gain accreditation for a selection of the taught modules. It outlines the modules available to postgraduate students within these schemes and provides other information about assessment procedures, guidelines for preparing dissertations and other departmental policies. For any other information contact the Course Director, Professor Brian Francis (b.francis@lancaster.ac.uk)

1.1 The Department

The Department of Mathematics and Statistics is made up of the sections of Pure Mathematics and Statistics. The Statistics group at Lancaster forms one of the strongest statistical research groups in the UK.

In recognition of teaching excellence, in 2005 the Department was awarded a large grant by the Higher Education Funding Council for England to fund a *Centre of Excellence in Teaching and Learning* (CETL), the Postgraduate Statistics Centre, which specialises in postgraduate statistics training.

A new state-of-the-art building for the Postgraduate Statistics Centre, was opened in February 2008, providing excellent teaching facilities and attractive spaces where postgraduate students and staff can interact. MSc/PgDip/PgCert students have their own base-room and social area in the building.

The Department of Mathematics and Statistics is located in the Postgraduate Statistics Centre and on B floor of Fylde College, to which it is connected by a linking bridge.

1.2 Admission requirements

Candidates would normally hold at least an upper second class honours degree in a relevant discipline from a British University or CNAA; a comparable degree from a university or recognised degree awarding body in another country, or a relevant professional qualification or experience at an equivalent level.

A background of at least ‘A level’ mathematics or equivalent is an advantage.

1.3 Course Office

For current students enquiries about the day-to-day running of the course should be addressed to Angela Mercer in the course office (B78, Postgraduate Statistics Centre) or by email to a.j.mercer@lancaster.ac.uk.

1.4 Staff

Head of Department

Dr Andrey Lazarev

Director of Postgraduate Studies

Dr Debbie Costain

Course Director

Professor Brian Francis

MSc Coordinator

Angela Mercer

Lecturing Staff:

Dr Debbie Costain
Prof Brian Francis
Dr Steffen Grunewalder
Dr Gillian Lancaster
Dr Tom Palmer
Dr Andrew Titman
Dr Fang Wan

1.5 General Information for Current Students

General Information for current students is provided by the University, and includes **core information for postgraduate taught students**. It is a useful website to familiarise yourself with and is found at:

http://www.lancaster.ac.uk/current-students/

2 MSc in Quantitative Methods

2.1 Aims and Objectives

2.1.1 Aims

The MSc in Quantitative Methods is designed to provide students with a firm grounding in the joint roles of substantive theory, data collection and statistical analysis. Students are encouraged to explore ways in which this knowledge can be applied to study scientific, economic, health, sociological and management issues. Given staff expertise in applied statistics, Lancaster University is ideally placed to provide such a course.

2.1.2 Learning and Assessment Objectives

- **Knowledge and understanding**

By the end of the course, students should have acquired:

a) advanced knowledge of the interdependent roles of substantive theory, methods of data collection and statistical methods of analysing data,

b) a thorough understanding of problems inherent in designing, executing and evaluating research projects and published work.

These will have been acquired via:

a) direct transmission in classes,
b) discussion with tutors and peers,
c) independent study,
d) direct practical experience.

Assessment will have been based on a dissertation (an original investigation supervised by an expert in the topic) and on coursework relating to the taught modules (ranging from traditional essays to the writing up of practical work and other exercises as reports).

- **Skills and other attributes**

Students will have gained essential practical skills associated with conducting applied statistical research, including:

a) research design, data analysis, statistical modelling and interpretation,
b) using a range of software,
c) synthesising information from a variety of sources,
d) oral and written presentation skills.

Students will have been encouraged to relate their work to areas of research including science, medicine, education, management, social services, criminal justice and market research. They will also have developed skills of scientific reasoning and analysis, and transferable skills of communication. The dissertation will have provided the opportunity to consolidate these through experience of the research process. The range of skills will have been assessed through students' written work and oral presentations.

- **Intended learning outcomes**

Graduates from this programme will acquire the following learning outcomes.

A. Subject-specific knowledge and understanding:

A1. Understand the mathematical foundations of statistical techniques
A2. Demonstrate technical expertise in a range of statistical methods for the design and analysis of scientific and social studies
A3. Use appropriate specialist statistical software packages for data analysis
A4. Recognise the problems inherent in designing, executing and evaluating research projects and published work
A5. Employ the knowledge and skills learned to producing a coherent summative piece of work in the form of a research dissertation that demonstrates scientific argument, formulating aims and objectives, and testing hypotheses through the application of contrasting statistical methods and the interpretation of results. (MSc only)

B. Practical skills

B1. Communicate statistical issues to non-statisticians and be able to understand problems from the collaborator's viewpoint
B2. Demonstrate competence in research design, data analysis, statistical modelling and interpretation
B3. Have an awareness of the range of modern statistical software packages available for data analysis
B4. Select and apply appropriate statistical methods for the problem at hand
B5. Be aware of the need for critical assessment of assumptions and the consequences of misuse of methods
B6. Demonstrate the ability to read, synthesise information from a variety of sources and critically appraise research publications.

C. Transferable skills

C1. Demonstrate the ability to engage intelligently in new situations and solve problems
C2. Produce well-constructed oral and written presentations
C3. Work effectively both independently and as part of a group
C4. Learn from various styles of presentation, reading lists, printed material and online media
C5. Demonstrate an enhanced capability for self-directed learning
C6. Learn and apply new methods taking a professional and flexible approach
C7. Proficiently manipulate IT resources to find information, including effectively accessing the library and other online information sources
C8. Demonstrate practical and efficient work organisation, time and project management skills.

2.2 Structure of MSc in Quantitative Methods

The MSc programme consists of core modules (50 credits), some optional modules (70 credits), followed by a dissertation (60 credits). Students can self-select their optional modules or follow designated pathways, thereby tailoring their training programmes according to their own requirements and research interests (Total 180 credits).

Students who do not wish to complete the full MSc programme may gain an alternative qualification. Students who receive 120 credits from the taught courses will be eligible for the Postgraduate Diploma in Quantitative Methods, and students who receive 60 credits from the taught courses will be eligible for the Postgraduate Certificate in Quantitative Methods.

PhD students registered at Lancaster University may also register for the Postgraduate Certificate or Postgraduate Diploma in Quantitative Methods as part of their Research Training Programme, subject to payment of the appropriate course fees.

Module assessment is by coursework except for MATH563: Clinical Trials and MATH564: Principles of Epidemiology (Statistical Methods for Health Research pathway) which also include an examination.

Compulsory core modules for MSc/PgDip (50 credits):
These modules cover the main methods of data collection, fundamental aspects of research design, and statistical methods of data analysis.

CFAS402a: Sampling Design *(5 credits)*
CFAS402b: Questionnaire Design *(5 credits)*
CFAS403: Secondary Data Analysis *(5 credits)*
CFAS406: Statistical Inference *(15 credits)*
CFAS407: Generalized Linear Models *(10 credits)* comprising of
GLM I: Introduction to Multiple Linear Regression, and
GLM II: Modelling Binary and Count Data
CFAS411: Multi-Level Models *(10 credits)*

Optional Modules for MSc/PgDip (70 credits):
In addition to the core modules students take a selection of optional modules from the list below. They may choose any module that is of interest to them. The designated pathways provide a suggested optional structure for those with particular professional interests. Please note that not all optional modules may run each year.

The CFAS450: Statistics in Practice module is taken each week over two semesters and is more suitable for students studying fulltime. It provides students with the range of practical skills necessary for applied statistical work, including team working, oral presentation, statistical consultancy and the preparation of written reports.

CFAS435: Teaching Statistics is a distance learning course for those who choose the Teaching Statistics pathway of the MSc. It is more suited to part-

time study and typically takes 18 months. It is a 60 credit course and may be taken as a stand-alone Postgraduate Certificate.

CFAS409: Duration Analysis (Survival Analysis) *(10 credits)*
CFAS412: Data Mining *(10 credits)*
CFAS414: Methods for Missing Data *(10 credits)*
CFAS415: Structural Equation Modelling *(10 credits)*
CFAS416: Bayesian Methods *(10 credits)*
CFAS450: Statistics in Practice *(10 credits)*

For Crime and Social Statistics pathway:
CFAS434: Methods for Analysing Crime Data *(10 credits)*

For Statistical Methods for Health Research pathway:
MATH563: Clinical Trials *(10 credits)*
MATH564: Principles of Epidemiology *(10 credits)*

Compulsory core and optional modules for PgCert
Two modules are compulsory for the PgCert. They are CFAS406: Statistical Inference and CFAS407: Generalized Linear Models. Any other module may be chosen as an optional module to make up the 60 credits.

Software modules:
These modules supplement the substantive and methodology modules. They are non-credit bearing and so do not require an assessment. The module on the R software package is compulsory. R is used in some of the methodology modules and is assessed through these modules.

CFAS422: R *(compulsory, non-credit)*
CFAS424: SPSS for Windows: I *(non-credit)*

Optional Support Modules:
These optional modules are provided as an introduction to the course and to give training in the fundamentals of mathematics and statistics:

CFAS404: Mathematics for Statistics *(non-credit)*
CFAS405: Statistical Methods *(non-credit)*

Dissertation (60 credits)
Following successful completion of the taught part of the course, MSc students conduct an original piece of research with subsequent submission of a dissertation of 50 pages maximum, based on empirical work undertaken in an area of applied statistics.

3 Integrated PhD in Quantitative Methods

Students awarded a 1+3 studentship (for MSc and PhD) may, by agreement with the scheme director, replace one or more optional modules with

appropriate modules provided by another department, provided the topic is related to the proposed PhD or provides generic research training.

In addition, students may be expected to attend external advanced courses in statistics which are given as part of the national Graduate Training Programme in Statistics organised by the Royal Statistical Society. There is no formal assessment of these courses.

3.1 Assessment and Progression

Year 1

An MSc will be awarded at the end of Year 1 if the weighted mean module mark is over 50% (with no individual mark below 40%) and at least 50% in the dissertation. Also see section 5.5.

To continue into Year 2 and study towards a PhD, students should have a weighted mean mark above 60% over all Year 1 modules and dissertation, and have no individual mark below 50%.

Years 2, 3 and 4

The PhD project will be reviewed by a supervisory panel and satisfactory performance will be needed for progression. The PhD will be examined in the usual way and satisfy the normal criteria for the award.

More information about PhD regulations can be found at:

https://gap.lancs.ac.uk/ASQ/QAE/MARP/Documents/MARP-current-version.pdf

4 Module Descriptions

4.1 Compulsory Modules

4.1.1 CFAS402a Sampling Design

Lecturers: **Professor Brian Francis**

Prerequisites: **Statistical Methods**

Contact hours and type: **5.5 hrs lecture/tutorial + 2 hrs practical**

Outline: The main aim of this module is to give a solid foundation to the understanding of sampling and sampling methods. Various methods of survey sampling will be considered and practical examples given throughout the module.

Topics covered will include:
1. Basic ideas of sampling
2. Sampling designs: simple random sampling, stratified sampling, proportionate stratified sampling, cluster sampling, multi-stage sampling, systematic sampling
3. Sample size determination and sampling frames
4. Experiments and investigations
5. Ways of collecting information
6. Sampling weights and non-response

Learning: Students will learn through the application of concepts and techniques covered in the module by application to real data sets. Students will be encouraged to examine issues of substantive interest in these studies.

Students will acquire a knowledge of:

- The basic principles of sampling
- Different types of sampling designs and which is appropriate to use in a particular circumstance
- Methods of collecting information

Assessment: An assignment covering all aspects of the module material.

Bibliography:

Barnett, V. (2002) *Sample Survey: Principles and Methods* Hodder Arnold

Kish, L.(1995) *Survey Sampling* . Wiley Classics Library.

Lohr, S (1999) *Sampling: Design and Analysis.*

Moser C.A., Kalton G., *Survey Methods in Social Investigation*

4.1.2 CFAS402b Questionnaire Design

Lecturers:	**TBC**
Prerequisites:	**none**
Contact hours and type:	**7.5 hrs lecture/discussion**

Outline: This module will provide students with the tools required to design questionnaires in an efficient and effective manner. There will be opportunity for students to discuss their own research interests.

Topics covered will include: useful resources, including the Item Bank; examples of current widely used questionnaires in the social sciences; examples of good and bad practice; interview schedule vs. self-completion form; structured vs. semi-structured instruments; types of questions and responses; wording of questions; routing, branching and funnel sequences; questionnaires for use in longitudinal surveys; designing web-based questionnaires; the concepts of validity and reliability.

Learning: Students will learn through the practical application of the techniques covered in the module. Students will be encouraged to participate and share their experiences.

Knowledge and Understanding:

By the end of the module students will:

- be familiar with a range of useful resources, including the Item Bank
- have an increased understanding of types of questions and responses and of the wording of questions
- be familiar with routing, branching and funnel sequences
- have increased competence in the design of questionnaires in a number of formats
- have an appreciation of how to address validity and reliability issues

Assessment will involve the design and piloting of a short questionnaire and an evaluation of its strengths and weaknesses.

Bibliography:

Fink, A. et al. 1995. *The Survey Kit Series of Books*. Sage.

Foddy, W. 1994. *Constructing questions for interviews and questionnaires: theory and practice in social research*. Cambridge University Press.

Houtkoop-Steenstra, H. 2000. *Interaction and the standardised survey interview: the living questionnaire*. Cambridge University Press.

Oppenheim, A.N. 1992. *Questionnaire design, interviewing and attitude measurement*. Pinter.

Rossi, P.H., Wright, J.D. & Anderson, A.B. 1983. *Handbook of Survey Research*. Academic Press.

Schuman, H. & Presser, S. 1981 *Questions and answers in attitude surveys: experiments on question form, wording and context*. Academic Press.

Streiner D.L., Norman G.R. and Cairney J. 2014. Health Measurement Scales: a practical guide to their development and use, fifth edition. Oxford.

Wilson, N. & McClean, S. 1994. *Questionnaire Design: A Practical Introduction*. University of Ulster.

4.1.3 CFAS403 Secondary Data Analysis

Lecturer:	**Professor Brian Francis**
Prerequisites:	**SPSS for Windows: I (or equivalent)**
Contact hours and type:	**5 hrs lecture/demonstration + 2.5 hrs practical**

Outline: This module introduces the skills and techniques involved in sourcing and analysing secondary data. The module consists of two parts. The first part is concerned with using the internet to discover secondary data sources and other material both in the UK and in other countries, and in finding both quantitative resources for research. The major British social surveys will be covered. Online access to the UK census data will also be demonstrated, and a GIS system demonstrated.

The second part of the module explores in detail two publicly available datasets, the Home Office Offenders Index birth cohort series and the ESRC British Household Panel survey (BHPS). The module will show methods of merging and aggregating datasets to produce information sources suitable for secondary analysis. Problems of data quality will also be addressed.

Learning: Students will learn through the application of concepts and techniques covered in the module to real data sets. Students will be encouraged to examine issues of substantive interest in these studies.

Successful students will:

- be familiar with the major sites for information on secondary data sources in the UK
- understand how to search for data at the ESRC data archive
- be aware of how to obtain UK Census data
- be able to download data and follow data documentation
- be able to construct data subsets by merging and aggregating data files from a major social science dataset using SPSS
- be aware of data quality issues in secondary data
- gain experience of using a simple GIS system for displaying spatial data.
- learn how to aggregate and merge and transform datasets to convert complex secondary datasets to those ready for statistical analysis

Assessment: By coursework, addressing a relevant social issue by extracting data from the BHPS and providing a suitable data analysis.

Bibliography:

Marc Riedel, *Research Strategies for Secondary Data*, Sage.

Angela Dale, Sara Arber and Michael Procter, *Doing secondary analysis*. London : Unwin Hyman

Catherine Hakim, *Secondary analysis in social research: a guide to data sources and with examples*. London : Allen & Unwin

Jill Kiecolt and Laura Nathan, *Secondary analysis of survey data*, Sage.

4.1.4 CFAS406 Statistical Inference

Lecturer:	**Dr Steffen Grunewalder**
Prerequisites:	**Statistical Methods**
Contact hours and type:	**25 hrs (mix of lectures and tutorials)**

Outline: This module aims to provide an in-depth understanding of statistics as a general approach to the problem of making valid inferences about relationships from observational and experimental studies. The emphasis will be on the principle of Maximum Likelihood as a unifying theory for estimating parameters. The module is delivered as a combination of lectures and practical's over four weeks.

Topics covered will be:

1. Revision of probability theory and parametric statistical models
2. The properties of statistical hypothesis tests, statistical estimation and sampling distributions
3. Maximum Likelihood Estimation of model parameters
4. Asymptotic distributions of the maximum likelihood estimator and associated statistics for use in hypothesis testing
5. Application of likelihood inference to simple statistical analyses including linear regression and contingency tables.

Learning: Students will learn through the application of concepts and techniques covered in the module by application to real data sets. Students will be encouraged to examine issues of substantive interest in these studies.

Students will acquire a knowledge of:

- Application of likelihood inference to simple statistical analyses including linear regression
- The basic principles of probability theory.
- Maximum Likelihood as a theory for estimation and inference.
- The application of the methodology to hypothesis testing for model.

and develop skills to:

- Apply theoretical concepts
- Identify and solve problems

Assessment: One assignment covering all aspects of the module material.

Bibliography:

Dobson A.J., (1983) *An Introduction to Statistical Modelling*, Chapman and Hall

Pawitan, Y. (2001). *In all likelihood: statistical modelling and inference using likelihood*. Oxford University Press.

Pickles A., (1984) *An Introduction to Likelihood Analysis*, CATMOG series Norwich: Geo Books

Patiwan, Y., (2001) *In all Likelihood*, Oxford University Press, Oxford.

4.1.5 CFAS407 Generalized Linear Models

Lecturers: **Professor Brian Francis**

Prerequisites: **Statistical Inference (or equivalent); experience in R**

Contact hours and type: 10 hrs lecture/demonstration + 5 hrs practical

The aim of this course is to consider generalized linear models as a broad class of statistical models to a variety of commonly encountered data analysis problems in the social and biological sciences. The course will also introduce the software package R as a tool for such statistical analysis.

It comprises of two components:

GLM I: Introduction to Multiple Linear Regression
GLM II: Modelling Binary and Count Data

The use of factors, covariates and their interactions to build a flexible class of relationships will be considered.

Topics covered will be:

- The basics: Linear models, General linear models and Generalized linear models;
- Different GLMs: Simple linear regression, multiple linear regression, regression with binary data, regression with count data;
- Use of continuous and categorical (factor) covariates;
- Using interaction terms;
- Model building and testing (F-test, ANOVA, Likelihood ratio test, AIC);
- Applications of GLMs;
- What to report;
- Using R for GLMs.

Assessment: Two pieces of coursework that will test the student's ability to select the appropriate statistical techniques to address a substantive issue.

Bibliography:

Agresti A., *Analysis of Categorical Data*, Wiley, New York

Aitkin M.A., Anderson D.A., Francis B.J. and Hinde J.P*., Statistical Modelling in R* , OUP

Dobson A., *An Introduction to Generalized Linear Models*, Chapman and Hall

Fox, John Applied regression analysis and generalised linear models. Sage

Fox, John and Weisberg, Sanford, An R Companion to *Applied Regression*, Sage

Liao, Tim Futing*, Interpreting Probability Models : Logit, Probit, and Other Generalized Linear Models*, Sage

R Development Core Team, *An Introduction to R*, http://www.stats.bris.ac.uk/R/

Tacq, Jacques, *Multivariate Analysis Techniques in Social Science Research*, Sage

Venables W.N. and Ripley B.D., *Modern Applied Statistics with S-Plus*, Springer

4.1.6 CFAS411 Multi-level Models

Lecturers:	**Dr Tom Palmer**
Prerequisites:	**Generalized Linear Models (or equivalent)**
Contact hours and type:	**10 hrs lecture/tutorial + 5 hrs practical**

The aim of this module is to introduce how to analyse data that has a multilevel, hierarchical structure. The aim is to also highlight the problems that can occur when the hierarchical structure of many datasets is ignored in routine statistical analysis. The classical 'variance components' analysis of variance (ANOVA) model will be described and extended to the multilevel models. Statistical analysis using multi-level models will be illustrated using appropriate statistical software.

Topics covered will be:

- The nature of heterogeneity and intra class correlation coefficient.
- Two level random intercept and random coefficient models with continuous outcomes.
- Checking model assumptions and residual diagnostics. Models with three or more levels.
- Generalized multilevel models including two-level logistic regression models, multi-level ordinal logistic regression models, and multilevel Poisson regression models.
- Worked examples are shown of fitting such models in statistical software such as R (examples using Stata, MLwiN, Julia and SAS are also available).
- Students will also gain insight into that there are different estimation algorithms available for multi-level models.

Successful students will be able to:

- Comprehend the notation used to describe multilevel models
- Demonstrate knowledge of multilevel models by formulating appropriate models to answer specific questions.
- Demonstrate and understand how to use statistical software to fit multilevel models and how to interpret the relevant output
- Demonstrate how to preform model diagnostics for such models

Assessment: A single assignment covering all aspects of the module material.

Bibliography:

Bryk, A. S., Raudenbush, S. W., (1992) *Hierarchical Linear Models*, Sage.

Goldstein, H., (2003) *Multilevel Statistical Models*. London, Edward Arnold.

Hox, J., (2002) *Multilevel Analysis*: Techniques and Applications, Mahwah, N.J: Lawrence Erlbaum Associates.

Longford, N. T., (1993) *Random Coefficient Models*. Oxford University Press.

Rabe-Hesketh S, Skrondal A. Multilevel and longitudinal modelling using Stata. Stata Press, 2005.

Snijders, T. A. B., and Bosker, R. J*., (1999) Multilevel Analysis. An Introduction to Basic and Advanced Multilevel Modelling*. London: Sage.

4.2 Supporting Modules

4.2.2 CFAS404 Mathematics for Statistics (non-credit)

Lecturers:	**Professor Brian Francis**
Prerequisites:	**none**
Contact hours:	**10 hrs**

Outline: This module is an introduction to the basic (and not so basic) mathematics needed in the Statistics World. The module will revise some topics covered in the A-level syllabus, and then introduce other topics students need to grasp in order to cope with the statistics used in this degree.

Therefore this module is intended for those people having only a GCSE in Mathematics, but who need to gain knowledge of material covered at A-level, such as calculus and matrices, or those who wish to refresh their knowledge.

The following topics will be covered:

- permutations and combinations
- functions
- algebra
- matrices
- calculus

After completing this module, successful students will:

- be able to cope with the mathematics needed in the other courses
- be familiar with calculus.
- know how to manipulate matrices
- know how to work with functions

Bibliography:

Pearson J.M. *Mathematics for Economists (A First Course)*

Jacques I. *Mathematics for Economics and Business*

Hagle T. *Basic Math For Social Scientists (Concepts)*

Croft A. and Davison R. *Foundation Maths,* Prentice Hall.

4.2.3 CFAS405 Statistical Methods (non-credit)

Lecturer:	**Dr Fang Wan**
Prerequisites:	**Mathematics for Statistics (or equivalent)**
Contact hours and type:	**15 hrs (mix of lectures and tutorials)**

Outline: Statistical Methods will introduce some commonly used discrete and continuous probability distributions, including the Binomial, Poisson and Normal families. Using these distributions, some simple statistical models will be discussed. Parameter estimation and sampling variability will then be introduced in the context of these models, but it will also be noted that these concepts extend to statistical models generally. The two most common ways to test a statistical hypothesis, critical regions and p-values, are covered next. Confidence intervals are then introduced to show how sampling variability can be quantified. The link between confidence intervals and hypothesis testing is explained. Finally methods for assessing association. Pearson's and Spearman's rank correlation and the chi-squared test for categorical data, are discussed.

Intended Learning Outcomes:

i. Subject

Specific students should become confident in the use of the R software package as a tool to carry out the statistical analysis of data. Given an unfamiliar data set, students should be able to produce sensible exploratory plots to look both at the distribution of the data and for any relationships between variables (when appropriate). They should be able to select an appropriate statistical model for their data, from the range of basic models covered in the course, and to then estimate the parameters in this model by the application of the method of moments technique. Students should be able to explain the concept of a sampling distribution and how this results in estimation uncertainty. In addition, they should also be confident in selecting and applying a correct hypothesis test for a given data set and research question and then interpreting the results of this test in the context of the original research question.

ii. General

This course acts as a gateway, for students who have had little past contact with any statistical methodology, to enable the understanding of more advanced statistical methods. On completion, students should be able to translate basic research questions into a statistical framework. They should be able to use basic functions in the R software package to enable the exploration and statistical analysis of data sets, and to understand why the use of such software is necessary. Students should be able to interpret and explain their findings in the context of the data set and original research question.

Bibliography

Rice, J.A. (2007) *Mathematical Statistics and Data Analysis 3rd Edition,* Duxbury

Crawley, M.J. (2014) *Statistics an introduction using R,* Wiley

Dalgaard, P. (2008) *Introductory Statistics with R 2nd Edition,* Springer

4.3 Optional Modules

4.3.1 CFAS409 Duration Analysis (Survival Analysis)

Lecturers:	**Dr Andrew Titman**
Prerequisites:	**Basic probability and statistics to the level of CFAS406; scientific writing or equivalent, computing in R**
Contact hours and type:	**10 hrs lecture/tutorial + 5 hrs practical sessions in which R will be used to apply the techniques.**

Outline: The main aim of this module is to give a solid foundation to the understanding of the statistical techniques required to make valid inferences about time to event data from observational or experimental studies.

Topics covered will include:

1. Basic concepts, including the hazard and survival functions
2. Non-parametric methods for survival analysis including Kaplan-Meier, Nelson-Aalen estimator and the log-rank test.
3. Cox proportional hazard modelling including stratified models, estimation of the baseline hazard function and methods for ties.
4. Inclusion of time dependent covariates within survival models
5. Model building and checking including
6. Parametric survival models including log-normal, Weibull and log-logistic accelerated failure time models

Learning: Students will learn by applying the concepts and techniques covered in the module to data from the social and health sciences. Students will be encouraged to examine issues of substantive interest in these studies.

Knowledge and understanding:

By the end of the module successful students will be able to

- apply a range of appropriate statistical techniques to survival data using statistical software.
- accurately interpret the output of statistical analyses using survival models fitted using standard software.
- Identify when particular models are appropriate through the application of diagnostic checks and model building strategies.

Skills and other attributes:

On successful completion of this module students will have improved skills in reporting the outcomes of scientific investigations, improved their ability to appraise the practical appropriateness of theoretical concepts and will have enhanced computing skills.

Assessment: One assignment covering all aspects of the module material.

Bibliography:

Collett, D. (2003) *Modelling survival data in medical research*, 2nd edition. Chapman & Hall.

Cox, D.R. and Oakes, D. (1984) *Analysis of survival data.* Chapman and Hall.

Hosmer, D. W. and Lemeshow, S. (1999) *Applied survival analysis: regression modelling of time to event data*. Wiley.

Kalbfleisch, J.D. and Prentice, R.L. (2002) *The statistical analysis of failure time data*. 2nd edition. Wiley.

Klein, J.P. and Moeschberger, M.L. (1997) *Survival analysis: techniques for censored and truncated data.* Springer.

Therneau, T. and Grambsch, P.M. (2000) *Modeling survival data: extending the Cox model*. Springer.

4.3.3 CFAS412 Data Mining Techniques

Lecturer:	**Professor Brian Francis**
Prerequisites:	**Generalized Linear Models (or equivalent)**
Contact hours and type:	**10 hrs lecture/demonstration + 5 hrs computer-based practical sessions**

Outline: The main aim of data mining is to extract knowledge, or information, which is stored in very large databases. This module covers many of the concepts that are fundamental to understanding and successfully applying data mining methods. Statistical concepts are discussed without mathematically complex formulation. Practical sessions will use the latest versions of standard software rather than data mining – the emphasis of the module is on techniques rather than data mining software.

The module will include the following:

1. formulating research objectives that can be translated into suitable analytical methods;
2. data structure and organisation;
3. model comparison and assessment;
4. data splitting;
5. assessing and interpreting predictive models;
6. introduction to variable selection;
7. benefits and drawbacks of neural networks;
8. examining the benefits and drawbacks of regression trees;
9. cluster analysis and latent class analysis;
10. bootstrap and cross-validation.

Learning: Students will learn through the application of concepts and techniques covered in the module to real data sets. Students will be encouraged to examine issues of empirical interest in these studies.

Successful students will be able to:

- identify empirical problems and determine suitable analytical methods;
- understand the difficulties presented by massive, opportunistic data;
- understand the concepts of using logistic regression, neural networks, projection methods and decision trees for predictive modelling;
- prepare data for analysis, including partitioning data;
- train, assess and compare regression models, neural networks and decision trees;
- understand the advantages and disadvantages of cluster analysis, latent class modelling and other latent variable methods.

Assessment: A series of short assignments covering all aspects of the module material (50%) plus a larger assignment (50%) that will test the student's ability to select the appropriate data mining techniques for a particular data set.

Bibliography:

Fayyad, U.M., Piatetsky-Shapiro, G., Smyth, P. and Uthurusamy, R. (Eds) (1996) *Advances in knowledge discovery and data mining*. Menlo Park, CA: AAAI Press.

Hand, D.J. (2000) 'Data mining - New challenges for statisticians', *Social Science Computer Review,* 18, 4, 442-449.

Hand, D.J., Mannila, H. and Smyth, P. (2001) *Principles of data mining*. Cambridge, MA: MIT press.

James, G., Witten, D., Hastie, T. and Tibshirani, R. (2013) *An Introduction to Statistical Learning* with Applications in R. Springer

Hastie, T., Tibshirani, R., Friedman, J. (2009)
The Elements of Statistical Learning Data Mining, Inference, and Prediction, Second Edition. Springer.

4.3.4 CFAS414 Methods for Missing Data

Lecturer:	**TBC**
Prerequisites:	**Generalized Linear Models (or equivalent)**
Contact hours and type:	**12 hrs lecture/demonstration + 5 hrs practical/tutorial**

Outline: This module deals with the problem of missing data common in many social surveys; problems of bias and inefficiency of naive statistical methods; alternative procedures: basics and complications; MCAR, MAR and non-ignorable missing data; selection bias and the problem of 'dropout' in panel studies. The module will also cover appropriate statistical analysis in appropriate software. The methods will be illustrated by case study analyses.

Topics covered will include:

- Exploration of missing data mechanisms
- Single imputation methods
- Bayesian imputation using WinBugs
- Rubin's rules for multiple imputation
- Multiple imputation using chained equations
- Multiple imputation using multivariate methods
- Multiple imputation diagnostics

On successful completion students will be able to:

- To demonstrate mastery of tools for exploring the missingness patterns using VIM and mice software libraries for R
- To formulate a possible missing data mechanism, for a given situation, and from this to identify cases where the missing data mechanism is ignorable.
- To formulate and differentiate: (1) The model for missingness, (2). The imputation model (3) the substantive model (model of interest)
- To be able to differentiate between sampling and parameter uncertainty and to recognise that the predictive distribution of the missing data incorporates both types of uncertainty
- To implement some naive methods for dealing with missingness (such as single imputation or list wise deletion), to recognise the limitations of each methods and identify situations where their use may be appropriate
- To recognise the similarities and differences between a fully Bayesian approach and a multiple imputation approach
- To be able to explain the differences between a multivariate imputation model and one using chained equations.
- To estimate the between imputation variability and the within imputation variability and to combine in a sensible way to estimate the total variability and the fraction of information lost through missingness

Bibliography:

Stef van Buuren, 2012 Flexible Imputation of Missing Data, (Chapman & Hall/CRC Interdisciplinary Statistics Series).

James R. Carpenter and Michael G. Kenward , 2013. Multiple Imputation and Its Application (Statistics in Practice). Wiley.

Assessment: A single assignment covering all aspects of the module material.

4.3.5 CFAS415 Structural Equation Modelling

Lecturers:	**Dr Andrew Titman**
Prerequisites:	**SPSS for Windows I (or equivalent); Generalized Linear Models (or equivalent)**
Contact hours and type:	**8 hrs lecture/demonstration + 4 hrs practical**

Outline: This module will introduce participants to latent variables (variables which are not directly measured themselves) and to the use of factor analysis in investigating relationships between latent variables and observed, or measured, variables. These techniques will then be extended into the wider area of structural equation modelling, where complex models involving several latent variables will be introduced.

The module is aimed at researchers and research students who have experience of statistical modelling (up to linear regression) and hypothesis testing, who wish to develop techniques to analyse more complex data involving latent variables. The aim of the module is to provide a background of theory with opportunities to apply the techniques in practice, and each session will consist of a lecture/ demonstration and a practical. The software packages used will be IBM SPSS and AMOS, and while participants will be expected to be familiar with SPSS, no knowledge of the structural equation modelling package AMOS will be assumed.

In summary, the following topics will be covered:

1. introduction to latent variables and measurement error
2. exploratory and confirmatory factor analysis; measurement models
3. structural equation models
4. theoretical issues involved in the development and application of structural equation models.

Learning: Students will learn through the application of concepts and techniques covered in the module to real data sets. Students will be encouraged to examine issues of substantive interest in these studies.

Successful students will be:

- familiar with latent variables and factor models
- able to investigate data using factor analysis
- able to confirm hypotheses and develop structural equation models
- able to apply theoretical concepts
- able to identify and solve problems
- able to analyse data using appropriate techniques
- able to interpret statistical output.

Assessment: One assignment (100%) to be submitted in the form of two reports covering all aspects of the module material. The projects involve

investigating datasets that require the student to investigate a substantive issue using appropriate statistical techniques and interpreting the results.

Bibliography:

Byrne, B.M. (2010) *Structural Equation Modelling with AMOS: Basic Concepts, Applications and Programming.* New York: Routledge

Kline, R. B. (2010) *Principles and Practices of Structural Equation Modelling* London: The Guildford Press.

4.3.6 CFAS416 Bayesian Methods

Lecturer:	**TBC**
Prerequisites:	**Generalized Linear Models (or equivalent)**
Contact hours and type:	**12 hrs (8 hours lectures + 4 hours practical)**

This module introduces students to the use of Bayesian methods for data analysis in the social and empirical sciences. It also provides an introduction to the basic concepts of Bayesian approaches to statistics, ideas such as the subjective interpretation of probability, types of prior distributions, the use of Bayes theorem in updating information, and inference procedures such as Bayesian parameter estimates will be introduced to the student. The main focus of the module will be the application of Bayesian models in social sciences and related disciplines.

Topics covered will be:

An introduction to Bayesian analysis, single parameter Bayesian modelling, informative priors, noninformative priors, posterior and predictive distributions, conjugate distributions, Bayesian forms of confidence intervals, Bayesian regression and General Linear Models using MCMC methods and OpenBUGS.

Exercises will be provided as part of the practical sessions. The assessment will be a short assignment on Bayesian model fitting using OpenBUGS.

Students will acquire a knowledge of:

- the fundamental notion of Bayes' theorem and the theory of inverse probability
- the relationship between Bayesian methods and classical likelihood methods
- the use of Bayesian methods to combine prior information with data
- the basic concepts of Bayesian inference, including posterior conditioning, credible intervals, prior distributions, and the likelihood principle
- an introduction to Monte Carlo Markov Chain (MCMC) methods
- application of MCMC using OpenBUGS to real estimation problems

and develop skills to:

- apply theoretical concepts
- examine model fitting in practice using Bayesian principles
- explore applied Bayesian modelling

Bibliography

Gelman, A. Carlin, J.B. Stern, H.S. and Rubin, D.B. (2004) *Bayesian Data Analysis*. Chapman & Hall/CRC, Boca Raton.

Lee, P (1998). *Bayesian Statistics: an introduction*. Halsted Press, New York.

Ntzoufras, I.(2009) Bayesian Modeling Using WinBUGS, Wileys.

Spiegelhalter, D. J, Thomas, A., Best, N., and Lunn, D. (2003). *WinBUGS Version 1.4 User Manual.* MRC Biostatistics Unit, Cambridge, UK. (a version of WinBUGS, OpenBUGS, is freely available from http://www.openbugs.info/w/).

4.3.8 CFAS434 Quantitative Criminology

Lecturer:	**Professor Brian Francis**
Prerequisites:	**Generalized Linear Models (or equivalent); Multi-level Models**
Contact hours and type:	**10 hrs lecture/demonstration + 5 hrs practical/tutorial**

Outline: The aim of this course is to enable students to understand and to use the latest methods in analysing quantitative datasets in criminology, and to understand the need for good design in carrying out quantitative studies for evaluation.

The topics covered will be:

Measuring crime. Experimental studies in criminology; quasi-experimental designs. Randomised trials in criminology. Case- control and matched case-control designs. Propensity score matching. Use of propensity scores in criminology. Multi-level models for modelling crime data.

Introduction to Latent structure models. Latent class models. Classifying patterns of criminal careers. The Moffitt taxonomy of criminal behaviour. Use of latent trajectory models. Growth mixture models and latent growth models. Examples from the literature.

The software used will be a mix of SAS, R and specialist software such as MPLUS.

Successful students will be able to:

- understand and fit a wide variety of latent structure models to criminological data
- understand the various types of research design used in quantitative criminological studies
- carry out a propensity score analysis
- gain state of the art knowledge in the analysis of criminological data and to be able to carry out such analyses
- understand and criticise a number of recent papers published in the literature
- understand the need for design in evaluation, and the various methods used in such evaluation.

Bibliography:

Bushway, S. and Wiesburd, D.(2005) Quantitative methods in criminology. Ashgate

Collins, L. And Lanza, S. (2010) Latent Class and Latent Transition Analysis: with Applications in the Social, Behavioral, and Health Sciences. Wiley, New York.

Curran, P.J. (2005) Latent curve models. Wiley: New York.

Guo,S, and Fraser, M.W. (2009) Propensity Score Analysis. Sage.

Piquero, A. and Wiesburd, D. (2010) Handbook of Quantitative Criminology. Springer: New York.

Von Montfort, K., Ord , J. and Satorra, A.(2010) Longitudinal research with latent variables. Springer: New York.

4.3.12 CFAS450 Statistics in Practice

Lecturers:	**Dr Chris Nemeth, Dr Tom Palmer**
Prerequisites:	**None**
Contact hours and type:	**26 hrs lecture/workshop (spread over Terms 1 and 2)**

Outline: The aim of this module is to provide students with a range of skills which are necessary for applied statistical work, including team-working, oral presentation, statistical consultancy and the preparation of written reports of various kinds.

The topics covered will include:

- **Scientific writing** (Term 1)
- LaTeX
- Scientific writing style (e.g. consulting report, journal article)
- Literature search and referencing
- Graphical and tabular presentation

- **Oral presentation** (Term 2)
- How to communicate effectively, design of slides/overheads/handouts, good and bad-habits in public speaking
- Beamer as a presentation package

- **Study design, consultancy and communication** (Term 2)
- Overview of the principles of study design and be able to recognise and discuss statistical design issues
- Appreciate and advocate the role of the statistician in the research process
- Consolidate the skills necessary to become a statistical consultant, including professionalism.

Learning: On completion of the module a student should be able to use type-setting software; demonstrate appropriate report writing structure; present data appropriately in graphs and tables and undertake basic statistical consulting.

Assessment: A set of exercises with one piece of assessed work under each of the three headings:

- written report of an analysis to include mathematical, tabular and graphical material
- oral presentation of an analysis using Beamer to produce over-heads
- designing a study to address a specific problem

Bibliography:

Altman D G (2008) Practical Statistics for Medical Research (2nd Edition). Chapman and Hall

Chatfield C (1988) Problem solving. Chapman and Hall, London.

Lamport L (1994) LaTeX: a document preparation system. Addison Wesley.

Tufte ER (2001) The visual display of quantitative information. Graphics Press

4.3.13 MATH563: Clinical Trials

Lecturers:	**Dr Debbie Costain**
Prerequisites:	**Basic probability and statistics to the level of MATH230 and MATH235; MATH550 computing and scientific writing or equivalent**
Contact hours and type:	**20 hours (lectures and practicals)**

Outline: This course aims to introduce students to aspects of statistics, which are important in the design and analysis of clinical trials.

Clinical trials are planned experiments on human beings designed to assess the relative benefits of one or more forms of treatment. For instance, we might be interested in studying whether aspirin reduces the incidence of pregnancy-induced hypertension; or we may wish to assess whether a new immunosuppressive drug improves the survival rate of transplant recipients. On completion of the module students should understand the basic elements of clinical trials, be able to recognise and use principles of good study design, and be able to analyse and interpret study results to make correct scientific inferences.

Topics covered will include:

- Clinical trials fundamentals: trial terminology, Principles of sound study design and ethics
- Defining and estimating treatment effects: continuous and binary data
- Crossover trials: motivation, design issues and analyses
- Sample size determination; continuous and binary data
- Equivalence and Non-inferiority trials
- Systematic reviews and Meta Analysis

On Successful completion students will be able to
:

- understand the basic elements of clinical trials,
- Recognise and use principles of good study design, and be able to analyse and interpret study results to make correct scientific inferences.
- Determine the different approaches that can be taken in addressing clinical questions related to the effectiveness of treatments and other types of interventions.

Assessment: 50% project and 50% examination

Bibliography:

D.G. Altman, Practical Statistics for Medical Research, Chapman and Hall, 1991.

S. Senn, Cross-over trials in clinical research, Wiley, 1993.

S. Piantadosi, Clinical Trials: A Methodologic Perspective, John Wiley & Sons, 1997.

ICH Harmonised Tripartite Guidelines

J.N.S. Matthews, Introduction to Randomised Controlled Clinical Trials, Arnold, 2000.

4.3.14 MATH564: Principles of Epidemiology

Lecturers:	**Dr Tom Palmer**
Prerequisites:	**Basic probability and statistics to the level of MATH230 and MATH235; MATH550 scientific writing or equivalent, computing in R**
Contact hours and type:	**20 hours (lectures and practicals)**

Outline: Epidemiology is the study of the distribution and determinants of disease in human populations. This course provides an introduction to the principles and statistical methods of epidemiology. Various concepts and strategies used in epidemiological studies are examined. Most inference will be likelihood based, although the emphasis is on conceptual considerations.

The topics covered include:

1. The history of epidemiology and the role of statistics
2. Measures of health and disease: incidence, prevalence and cumulative incidence risk
3. Types of epidemiological studies: randomized controlled trials, cohort studies, case-control studies, cross-sectional and ecological studies
4. Causation in epidemiology
5. Potential errors in epidemiological studies: selection bias, confounding
6. Remedies for confounding: standardized rates, stratification and matching
7. Diagnostic test studies

Successful students will be able to:

- Appreciate the history of epidemiology and the role of statistics
- Define and calculate appropriate measures of disease incidence, prevalence, cumulative incidence risk and mortality.
- Describe the key statistical issues in the design of ecological studies, surveys, case-control studies, cohort studies and RCTs and their advantages and disadvantages.
- Discuss strategies for dealing with bias and confounding.
- Evaluate diagnostic and screening test in terms of design and analysis issues.

Assessment: 50% project and 50% examination

Bibliography:

R. Beaglehole, R. Bonita and T. Kjellstroem (1993) *Basic epidemiology*. Geneva: World Health Organization.

D. Clayton and M. Hills (1993) *Statistical models in epidemiology*. Oxford: Oxford University Press.

Woodward M (1999) *Epidemiology: Study design and data analysis*. Chapman & Hall, Boca Raton

K.J.Rothman, S.Greenland and T.L. Lash. Modern Epidemiology. Lippincott Williams & Wilkins, US, 2008.

4.4 Software Modules

4.4.2 CFAS422 R

Lecturers:	**TBC**
Prerequisites:	**Statistical Methods (or equivalent)**
Contact hours and type:	**10 hrs lecture/demonstration + 5 hrs practical**

Outline: R is both a statistical language and a major statistical software product, providing the main route to dissemination of recent statistical methodology (free to download from the internet). This module introduces R, explains the syntax and introduces a wide range of statistical models which can be fitted.

Topics covered include: an introduction to the R language, reading data, data description and graphics, the generalised linear model (GLM), analysis of variance, logistic regression, survival analysis, multivariate techniques, the use of R libraries and www resources in R.

In summary, the following topics will be covered:

1. manipulation and management of data in the R environment
2. summarising data numerically and graphically
3. fitting linear models in R
4. statistical analysis using R
5. functions, iterations and conditions in R

Learning: Students will learn through the application of concepts and techniques covered in the module to real data sets. Students will be encouraged to examine issues of substantive interest in these studies.

Successful students will:

- have an increased understanding of the R programming language
- be able to produce basic statistics and create graphs
- be familiar with the R syntax for writing functions, iterations and conditions
- be familiar with linear models in R

Bibliography:

Crawley, M.J. (2005) Statistics: an introduction using R Wiley, New York.

Dalgaard, P. (2002) Introductory Statistics with R. Springer. Faraway, J (2004) Linear models with R. Chapman and Hall.

Maindonald, J. and Braun, J. (2003) Data analysis and graphics using R. Cambridge University Press.

Venables, W and Ripley, B (2002) Modern Applied Statistics with S . Springer.

Venables, W and Smith, D (2002) An introduction to R. Network Theory Ltd.

(or downloaded for free from http://cran.r-project.org/manuals.html)
R is freely downloadable from: http://cran.r-project.org/
R Web book: http://cran.r-project.org/doc/FAQ/R-FAQ.html

4.4.3 CFAS424 SPSS for Windows: I

Lecturers:	**Dr Tom Palmer**
Prerequisites:	**Statistical Methods**
Contact hours and type:	**10 hrs lecture/demonstration + 5 hrs practical**

Outline: SPSS for Windows is a statistical software package that has become synonymous with data management and analysis in the social sciences. This module will introduce participants to the manipulation and management of data in the SPSS Windows environment. In addition, participants will develop the confidence to manipulate data files in order to summarise data numerically and graphically and to perform simple statistical procedures including formal tests of hypotheses of interest.

This module is aimed at researchers and research students, with little experience of Windows computing, who would like to use SPSS in an efficient and effective manner. The aim of the module is to provide participants with as many opportunities to experiment with the package as possible. Consequently, each session will be centred around a computer-based practical encouraging participants to investigate data taken from various sources.

The following topics will be covered:

1. manipulation and management of data in the SPSS Windows environment
2. summarising data numerically and graphically
3. simple statistical procedures including formal tests of hypotheses of interest

Learning: Students will learn through the application of concepts and techniques covered in the module to real data sets. Students will be encouraged to examine issues of substantive interest in these studies.

Successful students will be able to:

- manipulate and manage data in the SPSS Windows environment
- summarise data numerically and graphically
- carry out simple statistical procedures including formal tests of hypotheses of interest
- apply theoretical concepts
- identify and solve problems
- analyse data and interpret statistical output
- apply strategies for appropriate selection of information

Bibliography:

Bryman A. and Cramer D., *Quantitative Data Analysis with SPSS for Windows,* Routledge

Kinnear P. R., *SPSS for Windows made Simple,* Hove

Norusis M., *The SPSSX guide to Data Analysis,* SPSS Inc

4.5 Dissertation

CFAS490 Dissertation

Dissertation Coordinator:	**Professor Brian Francis**
Prerequisites:	**successful completion of taught modules**
Contact hours and type:	**25 hours total supervision**

Outline: After successful completion of the taught modules students should be able to apply the knowledge that they have learnt and apply them to a project in applied statistics of direct relevance to their career or career plans.

A suitable topic for the dissertation will be agreed with the student after discussion and an appropriate supervisor (or two supervisors) will be nominated. These will generally be members of university academic staff.

Learning: Students will demonstrate that they have understood the interdependencies between data, methods of analysis and substantive theory in a piece of applied research undertaken on an individual basis with regular supervision.

Successful students will:

- be able to apply the knowledge that they have learnt through the taught modules to a new substantive area
- demonstrate skills of research, problem solving, analysis, synthesis and academic writing
- demonstrate the ability to communicate through written and oral presentation.

Assessment:
The dissertation should contain a maximum of 50 pages of single spaced A4 typescript, including all figures, tables, references and appendices. A 12pt font and standard margins should be used.

It should be presented in the style of a formal scientific report, with chapters and sections, and including an abstract, introduction, conclusions and a reference list.

Part of the assessment of the dissertation is through a 15 minute oral presentation, which will take place in late August or early September.

There will be a strict deadline in mid-September for the submission of completed dissertations. Two hard copies and an electronic copy should be submitted to the MSc Coordinator in the Course Office.

4.6 Other Non-assessed Module

CFAS430 Dissertation Writing

Module Coordinator: **Prof. Brian Francis**

Prerequisites: **none**

Contact hours and type: **3 hrs seminar/groupwork/presentations**

Outline: This module provides a forum for students' questions about dissertation writing. Through group work and presentations, it will guide the students into understanding the nature of scientific writing. It will also cover the skills necessary to carry out a dissertation project including time management issues. It will encourage awareness of areas of writing in which students commonly have problems, and suggest ways of developing strategies to counter these problems.
Topics covered will be time management, dissertation writing, scientific style.

Successful students will be able to:

- demonstrate how to effectively manage the stages of the project and hand in on schedule [time management]
- adopt an appropriate academic scientific style for their projects
- understand some of the key expectations of dissertation writing and the criteria used in assessment
- demonstrate different ways of and models for structuring dissertations through analysis of past examples
- identify the qualities of a good project through analysis of past examples

Bibliography

Burton, D. (Editor) (2000) *Research Training for Social Scientists: A Handbook for Postgraduate Researchers.* Sage Publications Ltd.

Cooley, L. and Lewkowicz, J. (2003) Dissertation Writing in Practice: Turning Ideas into Text. Hong Kong University Press.

Craswell, G. (2004) *Writing for Academic Success: A Postgraduate Guide*. Sage Publications Ltd.

Hart, C. (2004) *Doing Your Masters Dissertation* (Essential Study Skills) Sage Publications Ltd.

Mittelbach, F., Goossens, M., Braams, J., Carlisle, D., Rowley, C. (2004) *The LaTeX Companion* (2nd Edition). Prentice Hall.

Rudestam, K.E. and Newton R.R. (2000) *Surviving Your Dissertation: A Comprehensive Guide to Content and Process*. Sage Publications Ltd.

5 Other Information

5.1 Term Dates

Michaelmas Term:

- 7 October 2016 to 16 December 2016
  - Welcome Week: 3 October 2016

Lent Term:

- 13 January 2017 to 24 March 2017

Summer Term:

- 21 April 2017 to 30 June 2017

Please note that postgraduate courses run throughout the year, including vacations.

5.1.1 Attendance

For each study module all time-tabled lectures, lab sessions and tutorials are compulsory. For all compulsory sessions attendance is monitored.

At the end of each credit-bearing module students will be given an assignment by the course tutor. This will have to be completed within about four weeks. There will be a published deadline for the submission of each piece of work.

One paper copy and **one electronic** copy of each completed assignment must be submitted.

The paper copy must be deposited by **12 noon on the deadline date** in the box labelled 'MSc/PGDip/PGCert in Quantitative Methods' in the Fylde-PSC link corridor (B Floor). It must be accompanied by a Coursework Cover Sheet and students must declare the work as their own. See Section 5.3 on the penalties for plagiarism. Binders should not be used when submitting coursework, but a single staple may be used. Please add page numbers.

5.2 Coursework Submission

The **electronic copy** must be uploaded on **MOODLE** by 5pm on the deadline date.

Students should comply strictly to the deadlines set for coursework submission. If there are exceptional circumstances, application can be made for an extension using the "**Application for Extension**" form (available from the course office, PSC B78) giving reasons. Otherwise penalties as described in Section 5.5.4 apply.

5.3 Plagiarism

Plagiarism involves the unacknowledged use of someone else's work, and passing it off as one's own. **The University deals very severely with students found guilty of plagiarism**.

This category of cheating includes the following:

a) Collusion, where a piece of work prepared by a group is represented as if it were the student's own;
b) Commission or use of work by the student which is not his/her own and representing it as if it were, eg:

- purchase of a paper from a commercial service, including internet sites, whether pre-written or specially prepared for the student concerned
- submission of a paper written by another person, either by a fellow student or a person who is not a member of the university;

c) Duplication of the same or almost identical work for more than one module;
d) The act of copying or paraphrasing a paper from a source text, whether in manuscript, printed or electronic form, without appropriate acknowledgement;
e) Submission of another student's work, with or without that student's knowledge or consent.

There is an approved framework to deal with plagiarism, which can be found in the University's Plagiarism and Malpractice Regulations and Procedures.

5.4 General Information on Assessment

5.4.1 Introduction

Taught postgraduate courses are assessed by assignments. Assessment is linked to each individual module. The regulations for assessment are contained in the Postgraduate Taught Assessment Regulations, which can be consulted via the web address:
https://qap.lancs.ac.uk/ASQ/QAE/MARP/Documents/PGT-Assess-Regs.pdf
This booklet gives more detailed information on the assessment regulations that apply to the MSc/PgDip/PgCert in Quantitative Methods programmes.

5.4.2 Assessment Registration

Students are automatically registered for assessment for all the taught modules that they have registered to take. Students are required to choose their options during Term 1 of each year, but options may be changed at the discretion of the Course Director. Should a student wish to drop an option (after being entered for assessment), he/she should inform Angela Mercer, MSc Coordinator as soon as possible.

5.4.3 External Examiner

All assignments will be independently checked. Assignments, model solutions and marking schemes will be scrutinised by an appointed external examiner. Precise marking schemes will be employed for assignments. The Course Director will have responsibility for overall comparability.

Marked assignments and submitted dissertations will be examined by the external examiner who will assess the dissertation in the same manner as an MPhil/PhD degree, with the exception of dissertation length and minimum period of study. An internal examiner (who may be the Course Director, provided he/she is not the supervisor) will liaise with the external examiner and provide any additional information as is necessary. The appointed external examiner for 2016/17 is Dr Stephen Tagg, University of Strathclyde.

5.4.4 Marking Criteria for Assessment

Students will receive written comments prepared by internal assessors on individual pieces of coursework, together with a percentage mark. These are provisional marks which will be moderated by external examiners and require ratification by the Board of Examiners. The information below gives guidance on the general criteria used to assess submitted work. Specific assessment criteria relating to individual modules will be explained by the module tutor.

Criteria for Substantive Courses

70 and above – equivalent to a distinction
An outstanding piece of work in every regard which demonstrates:

- A thorough and wide-ranging knowledge of the substantive issues
- A thorough and insightful understanding of the substantive issues involved
- An ability to analyse critical contributions on the substantive issues
- An ability to research and bring together material to support an argument
- An ability to express an original, reasoned argument in a lucid manner
- Excellent research competencies in terms of presentation, language and referencing

60-69 – equivalent to a pass
A good piece of work which demonstrates:

- A sound understanding of the substantive issues involved
- A good knowledge of the critical contributions on the substantive issues
- An ability to organise research material
- An ability to present a clear, convincing argument
- Good research competencies in terms of presentation, language and referencing

50-59 – equivalent to a pass
A fair piece of work which demonstrates:

- A reasonable understanding of the substantive issues
- A familiarity with critical contributions on the substantive issues
- An ability to use research material to support ideas and arguments
- Competent research skills in terms of presentation, language and referencing

40-49 – equivalent to a fail (see Rules)
Work at this level will demonstrate:

- A general, but incomplete understanding of the substantive issues
- Some knowledge of the literature on the substantive issues
- Some ability to develop and support an argument
- A tendency to express ideas through description and anecdote rather than analysis
- Difficulties with presentation, language and referencing

39 and below – fail
This is an unsatisfactory piece of work which demonstrates:

- Little understanding of the substantive issues and their implications
- A limited amount of reading and poor knowledge of the previous contributions on the substantive issues
- Limited ability to formulate and sustain a clear argument
- Poor presentation skills and serious problems with language and referencing

0 – in cases where there is clear evidence of plagiarism or collusion the work will normally receive a mark of 0%.

Criteria for Methodology and Software Courses

70 and above – equivalent to a distinction
An outstanding piece of work in every regard which demonstrates:

- Good discussion of the limitations of the data and the modelling
- High competence in the use of appropriate statistical method(s) and software
- An ability to make good substantive interpretation of output in nearly all situations
- An ability to make an in-depth interpretation of output in most situations
- Excellent research competencies in terms of presentation, language and referencing
- Good suggestions for improvements in the design and analysis of the study being analysed

60-69 – equivalent to a pass
A good piece of work which demonstrates:

- High competence in the use of appropriate statistical method(s) and software
- An ability to make a basic level interpretation of output in most situations
- An ability to make an in-depth interpretation of output in a substantial number of situations
- Good research competencies in terms of presentation, language and referencing

50-59 – equivalent to a pass
A fair piece of work which demonstrates:

- Moderate competence in the use of appropriate statistical method(s) and software
- An ability to make a basic level interpretation of output in most situations
- An ability to make an in-depth interpretation of output in a substantial number of situations but not most situations
- Competent research skills in terms of presentation, language and referencing

40-49 – equivalent to a fail (see Rules)
Work at this level will demonstrate:

- Low competence in the use of appropriate statistical method(s) and software
- An ability to make a basic level interpretation of output in a substantial number of situations but not most situations
- An ability to make an in-depth interpretation of output in less than a substantial number of situations
-
- Difficulties with presentation, language and referencing

39 and below – fail
This is an unsatisfactory piece of work which demonstrates:

- Very low competence in the use of appropriate statistical method(s) and software
- An ability to make a basic level interpretation of output in less than a substantial number of situations
- An ability to make an in-depth interpretation of output in less than a substantial number of situations
- Poor presentation skills and serious problems with language and referencing

0 – in cases where there is clear evidence of plagiarism or collusion the work will normally receive a mark of 0%.

Plagiarism and Collusion

Cases of plagiarism will be reported to the Board of Examiners and will normally result in a fail mark for a module and can result in the failure of the course as a whole.

Deliberate plagiarism is uncommon, but you may break the regulations inadvertently by failing to explicitly attribute your sources. You must avoid this by adopting a recognised referencing system used consistently in the preparation and presentation of your work.

5.5 Procedures for Consideration of Results

5.5.1 Pass

The University's minimum threshold of attainment for the award of the postgraduate certificate, diploma or MSc shall be signified by a mark of 50% or more in all taught modules (plus 50% in the dissertation for MSc).

5.5.2 Merit and Distinction

The University's minimum threshold of attainment for the award of the qualification with Distinction shall be signified by an overall weighted mean mark of 70%. A Distinction may be awarded only to a candidate demonstrating a consistently high level of attainment across all assessed elements (including dissertation for MSc) of the programme.

A merit is awarded to students who obtain an overall weighted average mark of 60% or greater across all assessed elements (including dissertation for MSc).

5.5.3 Moderation

Each taught module will be subject to second marking: all completed assignments will be assessed by more than one marker, but the second marker will know the mark allocated by the first marker. Marks for individual modules may be moderated by a scaling procedure to ensure comparability with other modules.

Each MSc candidate submits two loose bound copies of their dissertation (and an electronic copy) to the Course Office. The dissertation is marked by two internal examiners (one usually being the project supervisor). Each internal examiner prepares a written report within one month of submission. The internal examiners make one of the following recommendations to the external examiner:
Distinction
Merit
Pass
Pass – minor textual corrections within one month
Fail – permission to resubmit, or award Diploma, at discretion of examiners
Fail.

5.5.4 Late submission of coursework

There are published deadlines for the submission of coursework; there are published procedures for the granting of extensions; work submitted after a deadline but within the time limit of an approved extension shall not be subject to penalty; work submitted late without an approved extension shall normally be penalised, as follows: work submitted 1-3 days late will have 10% of the maximum achievable mark deducted and material submitted more than 3 days late will be awarded a mark of 0.

5.5.5 Reassessment of failed modules/dissertation

Where a candidate obtains a mark of less than 50% for a module, he/she shall be entitled to one opportunity for reassessment in each failed module/element within the programme. Modules, if passed, may each be awarded a mark no greater than 50%. A failed dissertation may be resubmitted once, and reassessed for a maximum mark of 50%, at the discretion of the examiners. Such re-assessment must normally be completed within 12 months of the first attempt.

5.5.6 Condonation

To qualify for an award, candidates should pass all the assessments required by their programme. Notwithstanding this requirement, candidates shall be eligible for an award by condonation (the failure is ignored but the mark still counts) in respect of up to a maximum of 45 credits of a taught Masters programme (30 credits of a postgraduate diploma, 20 credits of a postgraduate certificate) provided that:

(a) no single module mark falls below 40%
(b) the candidate's weighted mean mark is 50% or greater
(c) the module(s) failed have not been designated by the department as essential to achievement of the programme's learning outcomes.

5.5.7 Dissemination of results

Under the Data Protection Act, the University is not allowed to disclose your results to any third party without your permission, except for the purpose of formal assessment. As soon as results can be released, they are made available via the Course Director. Note that the results are not officially confirmed until they have been seen by the External Examiner and Exam Board, and approved by Senate. Please note that an award will be notified officially only after clearance procedures have been carried out.

See the University's Postgraduate Taught Assessment Regulations for more detailed regulatory information. The web address is given above in Section 5.4.1.

5.5.8 Exit criteria

An MSc in Quantitative Methods is awarded to students who achieve a mark of 50% or more in each of the taught (including distance learning) modules amounting to 120 credits, together with a mark of 50% or more in the dissertation (60 credits).

For students who do not meet the requirements of the Master's programme, but who have successfully been awarded a minimum of 120 credits of taught modules, an exit qualification of Postgraduate Diploma in Quantitative Methods will be awarded. For this award, students will be able to demonstrate all intended learning outcomes (see Section 2.1.2), with the exception of outcome A5 of the Master's programme.

For students who do not meet the requirements of the Master's programme but who have successfully been awarded a minimum of 60 credits of taught modules, an exit qualification of Postgraduate Certificate in Quantitative Methods will be awarded. For this award, students will be able to demonstrate aspects of all the intended learning outcomes, with the exception of outcome A5 of the Master's programme.

For students who do not meet any of the above requirements but who have successfully been awarded a minimum of 20 credits of taught modules, an exit qualification of Postgraduate Certificate of Achievement will be awarded. For this award, students will be able to demonstrate limited aspects of all the intended learning outcomes, with the exception of outcome A5 of the Master's programme.

5.6 Guidelines for the Preparation of Dissertations

The guidelines for the supervision and preparation of dissertations for the award of MSc in Quantitative Methods follow those for an MPhil/PhD degree, with the exception of dissertation length (maximum 50 pages) and minimum period of study (3 months full-time or part-time equivalent).

The University's general regulations on the supervision and preparation of dissertations will be made available on Moodle.

Dissertations must be submitted at the end of the course, and will be examined once a year, in October.

5.7 Seminars and Research Workshops

Students would also be encouraged to attend seminars and forum talks arranged by the Statistics Group, comprising staff and students from the Department of Mathematics and Statistics. The seminars, presented by invited speakers, usually take place on Friday afternoons. The forum, at which members of the Statistics Group present their current research work, usually takes place at Thursday lunchtimes.

5.8 Facilities for Postgraduate Students

5.8.1 Computing

Students will be able to attend introductory sessions on computing facilities and software and will also be introduced to the campus e-mail system.

Computer access is provided in the Postgraduate Statistics Centre, which is available for postgraduate use when it is not booked for teaching. In addition there are numerous open access PC Labs located around campus. The PC labs provide a wide range of software, some with printers (colour and monochrome) and scanning facilities. All lab PCs are connected to the campus network and internet. It is also possible to access University services remotely e.g. from home, or via a smart phone.

The Learning Zone is located centrally on Alexandra Square and is accessible 24-7. It provides relaxed surroundings for students to work within and bookable 'pods' for meetings, presentations and group work. Here the Information Systems Services (ISS) Service Desk can be contacted if you require any general computing-related assistance.

5.8.2 Library

Students have access to the facilities offered by the University library and the Department's small library.

5.8.3 General

Outside the Department, the University has in place a series of systems offering academic, administrative and personal advice and support. These comprise a wide range of student support facilities including the Student Support Office, Student Registry, Counselling Service, Medical Centre, Chaplaincy Centre, Harassment Network, Pre-School Centre, Disabilities Advisor, Effective Learning Advisor, Students' Union and Nightline. All postgraduate students will automatically become members of Graduate College.

5.8.4 Student Learning Advisor

Additional writing and study support for all students is available from Robert Blake who is the Student Learning Advisor for this Faculty. Robert can provide one-to-one consultations, for example, about academic writing, academic reading, note-taking strategies, and preparation for exams. He also runs scientific writing courses for international students. Additional study consultations are available if you think you have a disability, such as dyslexia, that affects your academic work.

Further information about consultations and drop-in sessions is available on the Moodle page: https://modules.lancs.ac.uk/course/view.php?id=282 which also contains many useful resources. Robert's office is A16 in the Engineering Building and his e-mail address is studyadvice.fstandshm@lancaster.ac.uk.

5.8.5 Student Support Services

We hope you have an enjoyable and productive time at Lancaster, but recognise that sometimes problems can affect your ability to study.

Please do not forget that it is your degree and your responsibility to seek help if you are experiencing difficulties. The University will do whatever is possible to assist you, within the Rules and Guidelines of the University, if you are having problems provided that we are aware of those problems. The problems may be personal, financial or academic.

If you find yourself getting into difficulties we strongly urge you to consult your department, the Graduate College, the Postgraduate Studies Office, Student Services, the Counselling Service, or the Students' Union Advice Centre.

Student Services are available via The Base, which sits at the western end of Alexander Square, next to the Library, and is home to the Student Services helpdesk and the Careers Service.

See http://www.lancaster.ac.uk/sbs/

COUNSELLING and ***MENTAL HEALTH*** - provides confidential and professional support on issues such as personal, family, social or academic matters over the short term, to more complex or difficult longer term problems. The service offers both appointment and drop-in sessions. A specialist student mental health advisor provides support for students with declared mental health difficulties.

HEALTHCARE - Students enjoy excellent health services with a GP practice, pharmacy and a private dental practice on site. Also there is a range of alternative medical healthcare treatments available through the chaplaincy centre.

DISABILITY - provides help for disabled students from the first enquiry to graduation.

INTERNATIONAL STUDENTS - provides advice on visa extension, rules on working in the UK, general welfare and cultural orientation. They are the designated point of advice for immigration issues.

STUDENT FUNDING - provides information and advice on financial support and aid, including loans and advice on living costs and budgeting. The section manages a range of University financial awards.

GENERAL WELFARE - assists with a range of issues (personal, general, welfare, study-related) impacting on academic life and experience. This includes guidance on changing direction by suspending, transferring or withdrawing from a course of study.

CAREER SERVICE

Whether you are thinking about going into work or thinking about further study, this service will support you through the whole process of identifying career choices. http://www.lancaster.ac.uk/careers/

Other Central Services

Please see: http://www.lancs.ac.uk/sbs/network/

THE CHAPLAINCY CENTRE:
An ecumenical environment providing another source of welfare, advice and often practical support from the various Chaplains.

HARASSMENT NETWORK:
The Harassment Network provides confidential support for any student or staff member who feels they are subject to harassment. Contact network members by phone (see internal telephone directory or by email at *HarassNet@lancaster.ac.uk*.

STUDENTS' UNION ADVICE CENTRE: offers a full range of financial and welfare advice to students.

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5.9 Safety Information

5.9.1 Safety at the University

Under Health and Safety regulations, all members of the University, including students, have an individual responsibility to co-operate to enable the University to comply with the law, and to ensure the workplace is safe for everyone. Students must take reasonable care for the health and safety of themselves and other persons who may be affected by the way in which they carry out their work.

The University has a general Statement of Safety Policy, a copy of which can be accessed at the web address:

http://www.lancs.ac.uk/depts/safety/newpolicy/Intropolicy.htm

Please observe all safety notices in University buildings. In particular, take note of any emergency exit signs and any notices detailing actions in the event of a fire or other emergency.

5.9.2 Safety within the Department

The Head of Department, Professor Andrey Lazarev has overall responsibility for safety within the Department. The Departmental Safety Officer is Dr Amanda Turner.

A fire drill is held in each University building at least once per term. The Fire Alarm signal is a loud ringing bell tone. You should treat all Fire Alarm signals as an emergency. In the event of a fire, raise the alarm and leave the building quickly and carefully, do not use the lifts, and make sure you assemble well away from the building as directed by security staff. In the event of an accident, you should try to contact a first-aider or the duty doctor at the University Health Centre (internal number 94130) and then make sure it is reported to the Departmental Office.

It is important that if you become aware of any safety hazards or if a problem has occurred then you should report the problem to a member of staff.

5.10 Academic Support

The Postgraduate Tutor will provide general academic and pastoral support. Additional support will be provided within the Department of Mathematics and Statistics by the Course Director, course lecturers and other members of academic staff. The Course Director or Tutor will meet on a regular basis with students to discuss progress.

5.11 Quality Assurance

The programme is reviewed each year in line with other current postgraduate courses. The external examiner is asked to submit a report commenting specifically on the quality of the course in terms of assignments and dissertations, student experience and as an activity within the current postgraduate portfolio of the Faculty of Science and Technology. The Head of Department then issues a formal reply to the examiner's report. These documents are available from the Course Director upon request.

A formal appraisal of student progress and academic teaching and supervision takes place at regular staff-student course committee meetings.

Standard departmental and extra-departmental staff development and appraisal schemes are used as mechanisms for assuring high teaching quality. Individual teaching profiles incorporate student feedback gathered through feedback questionnaires on each taught module. Any specific concerns can then be raised together with an individual appraiser during an annual appraisal. Formal staff development opportunities may be useful in facilitating development in response to specific concerns.

The external examiner's comments and student feedback are fed into the annual academic review along with staff experiences of success or shortcomings of particular modules and/or teaching methods. The annual academic review takes place in June.

For all other course information, news and events see the departmental website at:

http://www.lancaster.ac.uk/maths