THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY · 2052 · AUSTRALIA

SCHOOL OF SURVEYING & SPATIAL INFORMATION SYSTEMS

GMAT 2550

Data Analysis by Least Squares

Course Outline – Session 2, 2009

Version: 25/06/2009

This document, and other material, is available at the Course Website:
http://www.gmat.unsw.edu.au/gmat2550

(User name and password supplied in class)

Contents

1. Staff involved in the Course and their Contact Details

1.1 Course Convenor, Lecturer & Tutor: Dr. Bruce Harvey

Office, email, direct phone: EE424 B.Harvey@unsw.edu.au 9385 4178
The class web site's message section will be used as the primary means of contact with students outside of the scheduled classes. So monitor the site regularly.

Tutor: Peter Mumford EE413C

1.2 Staff absences during session:

Lecturer will be absent Tue - Sat of week 2 (year 3 survey camp).

2. Proposed Course Schedule

Chapters in the table below refer to Monograph 13, third edition.

Wk	**Wednesday** 9 – 10am, Lec in Quad G025	**Wednesday** 10 – 12 noon, Lab in EE401A	**Thursday** 1 – 3 pm, Lec in Quad 1047
1 22 Jul	Course Outline. Least Squares concepts & principles Ch1.	No Class	Why use LS? LS & means. Revision matrix algebra, differentiation, Excel. Ch 1.
2	No Class	LS Treasure Hunt game. Matrix algebra, differentiation, Excel	No Class
3	Statistics applied to surveying problems. Ch2.	Statistics problems	Input to LS programs. Preprocessing obs & std devs. Ch 3.
4	Lab: LS software Fixit3. Input trilateration.	Data collection, Pillar trilateration	Modelling observation equations, Parametric method. Linearisation. Ch 4.
5	Lab: Modelling & linearization	Modelling & linearization	Derivation of LS equations. Forming and solving normal equations. Ch 4.
6	LS aspects of EDM calibration	Forming & solving normal equations in Excel.	Least Squares step by step worked examples Ch4.
7	**Test in EE 401**	**Test in EE 401**	VCV matrices, residuals & VF. Ch 4. Review of Test
	Recess week		
8	Analysis of Output. Ch 5.	EDM baseline calculations and analysis	No Class
9	Analysis of Output. Ch 5.	Analysis of Output.	Outliers. Ch 6.
10	Redundancy. Ch 6.	Outliers.	Survey Design. Ch 7. Case Studies: Opera House, Harbour Bridge
11	Case Study: Chifley Dam control surveys	Simulations	Combined & condition methods. Ch 8.
12	Advanced LS. Ch9.	Combined & condition methods	LS Essentials and Predicting results. Ch 10.
13	Exam discussion and Revision	Final Lab session	Additional tutorial assistance in lecturer's office

3. Educational Aspects of the Course

Handbook description: Least squares principles and concepts. Reasons for applying least squares solutions to surveying observations. Determining input into, and analysing output from, typical least squares adjustment software. Modelling observations, observation equations, parametric method, condition and combined methods. Linearisation of equations. Derivation of least squares. Methods of forming normal equations. Worked examples in various areas of cadastral and engineering surveys. Calibration of EDM instruments. Variance-covariance matrices, error ellipses the application of statistics and error analysis in surveying. Computer programming for analysis and graphics related to least squares adjustment of survey networks. Introduction to advanced least squares.

3.1 How this course relates to others in the program

This course is a key element in the measurement and calculation part of the degree program. It builds on previous surveying calculation courses in first and second year, (Surveying & GIS 1, Survey Computations & CAD and Surveying 2). It assumes you have knowledge of the material in year one Maths (Maths 1A and 1B or higher) and year 2 Math / Statistics courses. You should have already passed or been exempt from those courses. If you have attempted but failed any of the above courses then you should contact the course convener. This course will connect with GMAT2130 Surveying 3 in several areas. The topics in this course are useful for year 3 and 4 survey courses (Survey Applications, Field Projects, GNSS and perhaps your thesis). **Assumed knowledge:** Basic plane survey computations, statistics, matrices, differentiation, solution of linear equations, use of Excel including matrix operations.

3.2 Aim of the Course

This course aims to introduce students to the analysis of surveying observations primarily by the least squares method and associated statistical analysis. One part of the course is applied LS, that is, how to use LS programs. The other part of the course is the theoretical aspects of LS and "what's inside LS programs". So the course studies both the application of software packages and the detailed calculations within such software.

3.3 Learning Outcomes

By the end of this course you should be able to:

- Understand the basic principles of Least Squares analysis
- Setup the equations within a parametric method least squares adjustment
- Calculate a least squares adjustment of data without using computer software
- Properly prepare data for Least Squares analysis, including a priori statistics
- Professionally interpret output from Least Squares analysis software, including variance factor and outlier investigations
- Design a survey network using least squares analysis, including error ellipses and redundancy number investigations
- Be familiar with computer programming aspects used within LS software
- Be aware of some more advanced aspects and types of LS analysis.

3.4 Teaching Strategies

This course and similar previous courses have been taught by the lecturer for many years, at UNSW and elsewhere. The teaching strategies have been refined over the years based on student feedback and student performance in exams and assignments. Generally lectures are presented on each topic via PowerPoint presentations. These PowerPoint files are available in pdf format for download from the class web site. Some students have said they don't like ppt in lectures, others do. So I try not to have static slides that are read, instead I ask students questions and use computer demonstrations. I also wrote the textbook (Monograph 13) and provide additional reading material on the class web site for students who prefer to learn by independent reading.

An important element of the teaching is the lab and tutorial classes where students are encouraged to work on assignments and tutorial problems in class with direct assistance from the lecturer. The small class sizes currently in this course make it possible to follow these strategies.

Another important aspect is that the main software used in this course has been written by the lecturer specifically for students in this course.

This is the first time this course has run in 12 in 13 week mode and the first time year 3 survey camp has run during session – thus the lecturers absence. In 2007 the course spanned 14 weeks, in 2008 it was 12 weeks, so we have no major problems with the week by week structure. However the lunch time slots for lectures that we have been assigned is not pleasant for any of us.

3.5 Suggested Learning Methods

You are encouraged to ask questions and participate in class discussions during lectures, tutorials and labs. Read the text and lecture slides. Attempt the tutorial questions and worked examples yourself. Get feedback: Ask the lecturer for help and help each other. After the mid session test visit me individually for feedback. AND after the end of the course you are welcome to see me and get feedback on your final exams and assignments and to collect any of your remaining submissions.

I encourage attendance in class and participation because I think it is better for your education than just reading the ppts. You will also notice that I say more in class than what is written on ppt slides. I do not like lectures that read the screen to you. So for example their might be a graphic chart, plan, map or photograph or table of numbers on the screen and we talk about it. If you want to learn by reading then that's what my textbook (monograph) is for, because the lecture ppts are missing some information.

3.6 UNSW Graduate Attributes

This course provides an environment that fosters in our students the following attributes is listed:

the skills involved in scholarly enquiry	Significant
an in-depth engagement with relevant disciplinary knowledge in its interdisciplinary context	Significant
the capacity for analytical and critical thinking and for creative problem solving	Significant
the ability to engage in independent and reflective learning	Some
the skills to locate, evaluate and use relevant information (Information Literacy)	Minimal
the capacity for enterprise, initiative and creativity	Some
an appreciation of and respect for, diversity	
a capacity to contribute to, and work within, the international community	
the skills required for collaborative and multidisciplinary work	Some
an appreciation of, and a responsiveness to, change	
a respect for ethical practice and social responsibility	

3.7 Feedback from last year's students

Last year and in previous years our students rated the course very highly in the CATEI surveys (above the school average and well above the faculty average). All the CATEI questions were highly rated, with no problems standing out. In the anonymous written comments section, the best features of the course were said to be the text book, the assessments, and the lecturer. Comments on how the course could be improved were rare. Some students suggested that the tutorial / lab questions should be marked because that forces students to actually do the tutorial work. So we will implement some marking of tutorial questions as described below.

Some students want to download the lecture notes before class. I usually put pdfs of the lecture ppts on our web site just before class because I improve them every year. But that makes interaction in lectures difficult if they already see the answers to my questions. So this year I will leave boxes on some slides for students to fill in answers after we discuss them in class.

4. Assessment in the Course

Assessment for the course includes:

• Mid-session test	30%	On Wednesday week 7
• Tutorial / Lab / Field work	25%	As described below
• Final Exam	45%	In formal exam period

Further details about tests and exams will be given in class. The final exam may cover all aspects of the course, not just those covered after the second mid session test.

The tutorial work will be marked in the student's presence by viewing the students' notes or computer screens and immediate feedback will be given. There is no need to rewrite the work or to submit formal well written reports. Generally the work will not be collected or be examined in detail unless a student has had difficulties getting correct or good quality output. Generally, tutorial/lab marks will be assigned using a mastery scheme, i.e. if the work is acceptable it will get full marks if it is not acceptable it will get zero marks, students can resubmit in this case. There will also be a time limit for tutorial work submissions; generally tutorial work is to be shown to the lecturer no more than two weeks after the class commences work on the tutorial.

5. Course Resources

5.1 Websites

Lecture Material (the course website): www.gmat.unsw.edu.au/gmat2550
Textbook website: www.surveying.unsw.edu.au/ls

5.2 Text and Reference Books

Harvey B.R., 2006, Practical Least Squares and Statistics for Surveyors, Monograph 13, Third Edition, School of Surveying and Spatial Information Systems UNSW, 2006.

Allan A.L., 2004, Maths for Map Makers, 2nd Edition, Whittles Publishing, UK

Further references are described in the text book.

5.3 Computational Aids

Pocket calculators are required during lecturing hours, for tutorials and practicals in this course. They have to be hand-held, internally powered and silent. They must be brought to all classes. Students may use any calculator they wish in this course, however in examinations they may not used pre programmed calculators with, for example, traverse close or resection programs. The type of calculator allowed is described by the University at my.unsw.edu.au/student/academiclife/assessment/examinations/Calculator.html Pocket calculators for the final examination in this course are not provided by the University. Some hints about the use of the CASIO fx-911W for surveying computations will be supplied on the class web site and in exam papers. You will NOT be asked to invert a matrix or multiply large matrices with a calculator in the mid session test or the final examination.

Computer software relevant to this course and available in the School's computer lab EE401, includes: FIXIT3 and MS Excel

6. Administrative Matters

6.1 Expected work load

At UNSW, the normal workload expectations of a student are about 150 hours per session for a 6 unit of credit course, including class contact hours, preparation and time spent on all assessable work.

Are you a full time student spending less than 40 hours per week on uni studies, including class time? Are you balancing time between courses, i.e. one 6 unit course should get close to the same amount of time as another 6 unit course.

6.2 Rules

Students should read the University Calendar or Student Guide for details of University Rules and special considerations.

Students are reminded that the University regards academic misconduct as a very serious matter. Unauthorised material must not be taken into a test or examination. The penalty for any suspected academic misconduct ranges from zero mark for the assignment or exam involved, through failure of the subject, to expulsion from the University. If absent from an examination, class test or practical, students must submit written documentation to the University, via the Student Centre in the Chancellery.

All assignments or practical reports are compulsory parts of the course and must be handed in by the due date. A mark of zero will be given for any submission which violates this rule. OR **The marks for late submissions will be reduced as follows:** -20% (of the maximum mark) for up to 24 hours after the scheduled submission time, then -10% (of the maximum mark) for each additional 24 hour period late. (For example, a student submitting a report/assignment 4 days late has his/her mark reduced by 4 if the maximum mark of the submission is 10.). Any late submission must be made before solutions are issued to the class.

If a student is unable to submit on time due to illness or other legitimate reason, then a brief written explanation must be given to the lecturer for consideration as soon as is feasible. In some cases the lecturer may grant an extension to the submission date provided he has been contacted before the due date.

Further assessment may be granted in this course at the lecturer's discretion. If further assessment is granted then performance in tutorials may be considered as well as an oral exam including use of a computer.

If students attend less than 80% of their possible classes they may be refused final assessment.

6.3 Grievances

In the first instance all grievances should be discussed with the lecturer involved. If the problem cannot be resolved, students should contact the School's Grievance Officer or Head of School, in writing.

6.4 Plagiarism

Plagiarism is the presentation of the thoughts or work of another as one's own.

The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at: www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students. Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

All assignment or practical reports should be submitted with a signed Plagiarism / Assessment Cover Sheet. See www.lc.unsw.edu.au/plagiarism and the UNSW web site for university policy on Plagiarism.

I/We declare that this assessment item is my/our own work, except where acknowledged, and has not been submitted for academic credit elsewhere, and acknowledge that the assessor of this item may, for the purpose of assessing this item:

Reproduce this assessment item and provide a copy to another member of the University; and/or,

Communicate a copy of this assessment item to a plagiarism checking service (which may then retain a copy of the assessment item on its database for the purpose of future plagiarism checking).

I certify that I have read and understood the University Rules in respect of Student Academic Misconduct.

Signed: .....date: ☐☐ ☐☐ ☐☐

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