QUEEN MARY, UNIVERSITY OF LONDON

MAS 314 Design of Experiments

Assignment 15 For handing in on 30 March 2007

Completed assignments should be given to me personally, either in a lecture or during one of my office hours, by 1530 on the due date. The work should be your own individual work, not group efforts. The assignment should consist of pages of writing and computer output either stapled together or enclosed in a document wallet. The pages of computer output should be separated and should be labelled (by hand). Please put your name and student number on the front page.

Answer any **FOUR** of the following questions.

1 Find out about a designed experiment from one of the following: (a) a friend in a university science department; (b) a scientific paper; (c) a newspaper or magazine. Write an essay about the design of this experiment, making clear any links to what you have learnt in this course.

2 (Question 1 from Assignment 3) A marine engineer is investigating ways of treating the standard metal components used in the construction of underwater structures at sea, such as piers and oil-drilling platforms. He wants to protect them against corrosion.

A colleague has developed a new sort of paint for the components. The engineer would like to see whether two coats of this paint give better protection than a single coat. So he will paint some metal components once, some twice, then immerse them all in his experimental tank of sea water. After three months, he will remove all the metal components from the tank, and measure the amount of corrosion on each.

He has a virtually unlimited supply of the metal components. The tank has room for up to 30 components. However, the paint is new, and there is enough for only 24 coats of paint.

Advice the engineer how best to use his resources in his experiment.

3 (Question 3 from Assignment 4) A psychology course has the 21 students shown below. The professor wants to use the students to test two new types of pill for keeping people awake, called Wakey-Wakey and Zizzaway. He has 10 pills of Wakey-Wakey and 10 of Zizzaway. He plans to use 20 students. Each student will be shut alone in the observation room, swallow their allocated pill, and then follow a set programme of activities until they fall asleep. A hidden watcher will record when they swallow the pill and when they fall asleep.

There is only one observation room, so only one pill can be tested per day.

Design the experiment for the professor, to the extent of giving him a plan allocating pills to students.

Your plan should show which student should take which pill on which day.

What information should you give the professor about the plan?

Name	Sex	Age	Name	Sex	Age	Name	Sex	Age
Adrian	M	19	Helen	F	20	Olivia	F	20
Belinda	F	20	Ingrid	F	20	Peter	M	20
Caroline	F	19	James	M	20	Quentin	M	27
David	M	20	Katherine	F	19	Ruth	F	20
Esther	F	28	Linda	F	28	Sarah	F	19
Fiona	F	20	Michael	M	20	Trixie	F	20
Gregory	M	19	Naomi	F	19	Ursula	F	20

For each of the next two questions you should submit output from your GenStat *session(s) with comments written on the output.*

4 (Question 5 from Practical 8) Groups of apples were stored in a shed in a 4×4 Latin square design.

C	B	A	D
D	A	C	B
B	C	D	A
A	D	B	C

There were four shelves along the side of the shed. Four groups of apples were stored on each shelf, so that 'column' represents distance from the door. The groups were labelled A, B, C, and D, where groups A and B were from one variety, groups C and D from another. Groups labelled A and C were stored for a short time, groups labelled B and D for a long time. At the end of the storage, the percentage weight loss was recorded for each group.

The data are in the file `apple.dat`. The first column gives the weight loss, the second gives the variety, the third the storage time. The order of the rows in the file is: all the groups on the top shelf, from left to right, then all the groups on the second shelf, and so on.

Analyse the data, showing the factorial treatment effects. Briefly interpret the output.

5 (Question 2 from Practical 9) We wish to detect a difference of magnitude δ between the responses to two treatments, and we guess that the variance of each response is σ^2. If we use equal replication r for both treatments, then the variance of the estimator of the difference between the two treatments is

$$\frac{2}{r}\,\sigma^2$$

if we use a matched pairs design. If we perform a significance test at level 5% and want to have probability at least 90% of detecting a difference as large as δ, then we saw in lectures that we need

$$(a+b)^2\,\frac{2}{r} \leq \left(\frac{\delta}{\sigma}\right)^2,$$

where a and b are the 97.5% and 90% points of the t distribution on d degrees of freedom, and d is the number of degrees of freedom for residual. We can rewrite this as

$$c \leq r, \tag{1}$$

where

$$c = \frac{2(a+b)^2}{(\delta/\sigma)^2}. \tag{2}$$

Suppose that by putting people into homogeneous blocks of size two we can reduce σ to 9. Assume that we use $2r$ people, in a complete-block design. Write down the new formula for d in terms of r.

Start with $r = 3$, and fill in the table below until Equation (1) is satisfied.

Step	r	d	c
1	3		
2			
3			

How many people are needed for the matched pairs design?