

THE OPEN UNIVERSITY OF SRI LANKA
 B.Sc/B.Ed Degree Programme/Continuing Education Programme
 APPLIED MATHEMATICS - LEVEL 04
 PSU2182/ PSE4182/ PSZ4130 – Design and Analysis of Experiments
 FINAL EXAMINATION 2008/2009



DURATION: TWO AND HALF HOURS.

DATE: 13-07 – 2008

TIME: 1.30pm – 4.00pm

ANSWER FOUR QUESTIONS ONLY.

Statistical Tables are provided. Non programmable calculators are permitted.

1. A researcher is interested in finding out which of the three food preservatives (say A , B and C) is more effective for preserving a milk product. Each preservative was added to 20 randomly selected samples of the milk product and the time (in days) taken for the milk product to perish was recorded. The results are presented in the accompanying table.

A	23	24	24	25	24	26	27	27	24	22
	21	20	21	20	20	24	27	25	21	20
B	18	17	15	15	17	14	16	16	14	17
	14	17	15	15	15	13	14	17	17	15
C	28	27	27	28	29	29	23	30	31	31
	34	27	28	28	29	31	30	20	25	29

- i) In relation to this study, state whether the following statements are true or false. Give reasons for your answer.
- The researcher has used a randomized complete block design.
 - The researcher has used a three-way treatment structure.
 - The design used in this study is a balanced design.
- ii) Write down a model for the response measured on a randomly chosen milk sample. Clearly describe the notation you use.
- iii) Give an estimate for the expected difference in times taken by two randomly selected milk samples to perish if the food preservative A is added to one sample and the preservative B is added to the other.
- iv) Give an estimate for the error in the estimate produced in part (iii).

2. A student has three routes to attend to the university from home. The student is interested in finding out whether the mean times he has to spent using these three routes are the same or not. If they are different, the student wants to find out the route that takes the shortest time. He recorded the time spent (in minutes) to come to the university using each route on 5 randomly chosen days. The results are presented in the accompanying table.

		Time (in minutes)				
Route	1	15	18	14	17	16
	2	22	26	24	26	24
	3	34	30	31	33	32

- i) Write down the null and the alternative hypotheses you would test to see whether the mean times spent on all three routes are the same or not.
 - ii) Test the null hypothesis stated in part (i) using a 5% significance level. Clearly state your findings.
 - iii) Compute the least significant difference for comparing the mean times spent on any pair of routes. Use a 5% significance level.
 - iv) Using part (iii) or otherwise determine whether any one of the three routes can be recommended as the one that takes the shortest time. Use a 5% significance level.
3. The following data were collected using a randomized complete block design where the sites indicate the locations of the plots on which the data were collected and *A*, *B*, *C* indicate the treatments. The response measured is the yield collected from each plot (in kg) within a month.

		Site			
		1	2	3	4
Treatment	<i>A</i>	8.4	8.2	7.8	8.0
	<i>B</i>	6.3	6.5	5.9	6.1
	<i>C</i>	9.8	10.4	9.9	10.2

- i) Write down a model for the yield measured on a randomly chosen plot.
- ii) Does the data indicate significant differences among different sites? Use a 5% significance level.
- iii) The researcher has resources to collect 12 more observations at the same sites to be used as a separate study to compare the three treatments. Based on the findings from this study, would you recommend the researcher to use the same design or not? If yes, give reasons. If not, clearly indicate how you would then advice to design the study.

4. A researcher is interested in comparing the effect of three fertilizers on the yield of beans. Two of the fertilizers (say P_1 and P_2) are rich in phosphate while the other is a potassium rich fertilizer (say K). The researcher selected nine plots for the study. Three plots are from the dry zone, three are from the intermediate zone and the other three are from the dry zone. The three plots selected from each zone are different with respect to the fertility levels say high, moderate and low.

- i) Suggest a suitable design for the study. Clearly indicate the fertilizer you apply to each plot and how the randomization is carried out.
- ii) Write down a model for the response measured on a randomly chosen plot. Clearly describe your notation.
- iii) Write down a comparison between the average treatment means of phosphate rich fertilizers and the potassium rich fertilizer.
- iv) Based on the model suggested in part (ii), describe how you obtain an estimate for the comparison suggested in part (iii).
- v) Write down another comparison between treatment means that is linearly independent to the one suggested in part (iii) above.

5. An experimenter is interested in comparing the mean yields of three varieties of potatoes (say A , B , C). The yields measured (in kg) from 15 plots that are more or less similar are presented in the following table.

Variety	Yield per plot (in kg)				
A	15	18	17	16	14
B	24	27	28	23	24
C	14	11	14	15	11

- i) Estimate the difference in mean yields per plot of varieties A and B .
- ii) Assume that the random variations of yields of all three varieties are the same. Give an estimate for the random variation of the yields obtained from different plots that have the same variety.
- iii) Construct a 95% confidence interval for the difference in mean yields of Varieties A and B .
- iv) Does the data indicate that the mean yields per plot of varieties A and B are significantly different at 5% significance level? Give reasons for your answer.
- v) Give an estimate for the total yield of three plots that have the three varieties.

6. A researcher is interested in finding out whether three fertilizers (say A , B , C) presently available in the market have similar effects on the growth of a medicinal plant. He plans to measure the increase in height (in cm) as the indicator of growth. The plots selected for the study are located in four sites that differ in the soil moisture level. The researcher selected three plots from each site and randomly selected a fertilizer to be applied to each plot. The increment in height recorded from the single medicinal plant in each plot and the fertilizer added are given in the accompanying table.

Site	Fertilizer applied		
	F_1	F_2	F_3
1	11	17	17
2	9	16	21
3	10	18	20
4	8	14	27

- i) In relation to this study, explain the following terms.
 - a) Treatment
 - b) Response
 - c) Blocking
- ii) Write down a model for the response measured on a randomly selected plot. Clearly explain the notation you use.
- iii) Consider the ANOVA table that can be used to address the researcher's objective. Compute the total sum of squares.
- iv) In completing the ANOVA table referred in part (iii), the total sum of squares will be decomposed into several sums of squares. Name these components and write down the corresponding degrees of freedom. You need not compute the values of these components.

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