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THE OPEN UNIVERSITY OF SRI LANKA  
B.Sc/B.Ed Degree Programme/Continuing Education Programme  
APPLIED MATHEMATICS - LEVEL 03  
PSU 2182/ PSE 4182 – Design and Analysis of Experiments  
FINAL EXAMINATION 2007/2008



056

DURATION: TWO AND HALF HOURS.

DATE: 01 – 07 – 2008

TIME: 1.30pm - 4.00pm

ANSWER FOUR QUESTIONS ONLY.

Statistical Tables are provided. Non programmable calculators are permitted.

1. A medical researcher is interested in determining which of the four different blood pressure pills are most effective in controlling a person's blood pressure. The researcher gave each blood pressure pill to five different people over a period of one month and recorded the average blood pressure loss. The data are presented in the accompanying table.

Blood pressure pill	Average systolic blood pressure loss (in mm Hg)				
<i>A</i>	22	11	17	15	10
<i>B</i>	12	16	18	13	15
<i>C</i>	19	11	14	15	18
<i>D</i>	16	3	9	10	11

- i) Write down the null hypothesis you would test, if the researcher requests you to find out whether the mean blood pressure losses for the four blood pressure pills are the same or not.
- ii) Test the null hypothesis stated in part (i) using 5% significance level. Clearly state your findings.
- iii) Compute the least significant difference for comparing any two treatment means. Use 5% significance level.
- iv) Determine whether any one of the four drugs can be recommended as most effective in controlling a person's blood pressure. Use 5% significance level.

2. A researcher interested in comparing the effectiveness of two fertilizers (say  $A$  and  $B$ ) with the present fertilizer widely used for bean cultivation (referred to as the control) designed a study as follows. Twelve plots of land that had bean plants of more or less similar age were randomly divided into three groups of four each. Plots in each group were treated with one of the three fertilizers. Soil conditions of the plots other than the fertilizers used and the plot sizes were quite similar. Yields (in bushels) per plot six weeks after applying the fertilizers were as follows.

Control group	Fertilizer $A$	Fertilizer $B$
29	24	25
33	27	24
26	33	33
27	31	32

- i) State whether the following statements are true or false. In each case, give reasons for your answer.
- The design used in this study is a completely randomized design.
  - One of the weaknesses in the design used in this study is that there are no replicates.
- ii) Write down a model for the mean response measured on a randomly chosen plot. Clearly describe the notation you use.
- iii) Test whether the data provide any evidence of significant differences among the three fertilizers. Use 5% significance level. Clearly state your findings.
- 3 The following data were collected in a randomized complete block design where the Site indicate blocks and  $A$ ,  $B$  and  $C$  indicate the treatments. The yields measured (kg) in 15 plots are given below.

		Site				
		1	2	3	4	5
Treatment	$A$	7.1	6.1	6.9	5.6	6.4
	$B$	6.7	5.1	5.9	5.1	5.8
	$C$	7.1	5.8	6.2	5.0	6.2

- i) Write down a model for the yield measured on a randomly chosen plot.
- ii) Test whether there is a significant difference between different treatments. Use 5% significance level. Clearly state your findings.
- iii) If several observations were collected in Site 1 using treatment  $A$  will they all be equal or not? If they are the same, give reasons. If they are not the same give an estimate for this variation. State any assumptions you make.

4. An agricultural scientist suspects that the yield of tomatoes is influenced by the type of fertilizer used and the amount of fertilizer applied. He selected two types of fertilizers (say  $A$  and  $B$ ) and with each fertilizer, he examined three amounts of fertilizer, which are 20, 25 and 30 milligrams per plot. Eighteen more or less similar plots were available for the study. He used three plots with each combination of fertilizer type and amount. The yields obtained (in grams) from the 18 plots are presented in the accompanying table.

Fertilizer type	Amount of fertilizer (in milligrams per plot)		
	20	25	30
$A$	74	73	78
	64	61	85
	50	44	92
$B$	92	98	66
	86	73	45
	68	88	85

- i) In relation to this study, explain the following terms.
  - a) treatment
  - b) replicate
  - c) response variable
- ii) Write down a model for the yield measured on a randomly chosen 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.

5. An experimenter is interested in comparing the effects of four different diets on the reduction of blood serum cholesterol levels. Sixteen men were randomly assigned to one of the four diet groups so that each group will have four men. After three months had passed, the blood serum cholesterol of each participant was determined and is given below.

<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
268	280	261	232
211	251	278	280
235	245	255	270
240	253	249	261

- i) Estimate the difference in mean blood serum cholesterol levels of patients receiving Drug *A* and Drug *B*.
  - ii) Assume that the random variation of serum blood cholesterol levels of patients is not dependent on the drug received. Give an estimate for the random variation of serum blood cholesterol levels.
  - iii) Construct a 95% confidence interval for the difference in mean blood serum cholesterol levels of patients receiving Drug *A* and Drug *B*.
6. A researcher is interested in finding out the type of catalyst and the temperature to be used to obtain the highest yield of precipitate from a chemical reaction. He is interested in four catalysts (*A*, *B*, *C* and *D*) and four temperatures ( $T_1, T_2, T_3$  and  $T_4$ ). The following table gives the yields of precipitate (in mg) measured on 16 samples using a Latin square design.

		Temperature			
		$T_1$	$T_2$	$T_3$	$T_4$
Catalyst	<i>A</i>	12	21	34	51
	<i>B</i>	10	19	37	41
	<i>C</i>	4	12	5	14
	<i>D</i>	12	10	3	16

- i) Estimate the difference between the mean yields from Catalyst *A* and Catalyst *B*.
- ii) Give an estimate for the standard error of the estimate found in part (i)
- iii) A student who wants to replicate the Latin square design mentioned in this study requests you to explain how the treatments are to be allocated to the samples. Briefly describe how you would advise the student.

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