

THE OPEN UNIVERSITY OF SRI LANKA

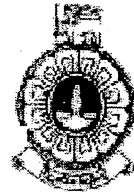
B.Sc. /B.Ed. Degree Programme, Continuing Education Programme

APPLIED MATHEMATICS-LEVEL 04

PCU3142/PSU2182/ PCU2142/PCE5142/PCE4142- DESIGN AND ANALYSIS OF EXPERIMENTS

FINAL EXAMINATION 2014/2015

Duration: Two Hours.



Date: 22.10.2015

Time: 1.30p.m- 3.30p.m

Answer FOUR questions only.

Instructions:

- This question paper consists of 06 questions and 04 pages.
- Statistical Tables are provided.
- Non-programmable calculators are permitted.
- Consider the level of significance as 0.05 for all the tests.

(1) A farmer wants to know whether four brands of insecticides , say E_1, E_2, E_3, E_4 , produced by four different companies have the same effect on the yield of potatoes.

(a) Assume that the farmer has 20 homogeneous plots of land prepared for growing potatoes.

Briefly explain how you would design an experiment to solve the farmer's problem.

(b) Instead of having 20 homogeneous plots as in part (a), if 5 blocks (each containing 4 homogeneous plots) are available, how do you design the experiment?

(c) Write down the suitable model for the designs in part (a) and part(b). Clearly explain all the terms in the models.

(2) An animal scientist conducted an experiment to compare the weight gain of chicks under four different types of diets ,say D_1, D_2, D_3 and D_4 . The scientist used 20 chicks that were in same age group for this experiment. A completely randomized design was used with 5 chicks for each type of diet. The results are shown in the following table.

Diet type	Weight gain (in grams)					Total
D_1	5	3	6	7	5	26
D_2	8	7	9	10	5	39
D_3	9	10	7	8	9	43
D_4	10	15	19	20	22	86

Total Sum of Squares = 526.2

- (a) In relation to this experiment, identify
- Response variable
 - Experimental unit
 - Treatments
- (b) Estimate the average weight gain for diet D_1 along with its standard error.
- (c) Construct a 95% confidence interval for the difference between the average weight gain for diet types D_1 and D_4 .
- (d) Using the result of part(c), test whether there is a difference between the average weight gain of diet types D_1 and D_4 . Clearly state the findings.
- (3) To evaluate 3 file management systems, a firm designed a test involving 5 different word processing operators. Since operator variability was believed to be a significant factor, each of the 5 operators was trained on each of the 3 systems in random order. The mean time (in weeks) to learn a system is given below.

System	Operator					Total
	1	2	3	4	5	
1	16	19	14	13	18	80
2	16	17	13	12	17	75
3	24	22	19	18	22	105
Total	56	58	46	43	57	260

Total Sum of Squares = 175.33

- Name the suitable design for the above experiment. Justify your answer.
- Specify the null and alternative hypotheses to test whether there is a significant difference in mean times to learn a system.
- Construct the complete analysis of variance table.
- Test your hypotheses in part(c) at 5% level of significance and clearly state the findings.

- (4) The effect of five different ingredients on the reaction time of a chemical process is being studied. Each batch of new material is only large enough to permit five runs to be made. Furthermore, each run requires approximately one and half hours. Only five runs can be made in one day. Batch of raw material as well as experiment run order are suspected to have effects on the reaction time. The experimenter decides to run the experiment using a suitable design and perform the analysis.

Assume that you were assigned to consult the experimenter to select a proper experimental model and perform the analysis of collected data.

- (a) In relation to this experiment, identify
- (i) Response variable
 - (ii) Experimental unit
 - (iii) Treatments
- (b) What experimental design you would select to perform the study? Justify your answer.
- (c) Write down the equation of the model you fit for the selected design clearly explaining the parameters in the model.
- (d) Clearly describe how you would design this study.
- (5) An engineer needs to study the effect of the brand and the temperature at the location where the equipment is utilized on the lifetime of a generator. He has decided to test two brands (*A* and *B*) of generators at two temperature levels. In the experiment, four groups of generators are randomly selected such that four machines are observed in each combination of brand and temperature level. The collected data are as follows.

Brand	Temperature level			
	15°C		25°C	
<i>A</i>	88	145	51	58
	152	175	37	65
<i>B</i>	170	122	152	102
	174	156	162	148

Total Sum of Squares = 34743.44

- (a) How many treatment combinations can be tested in this experiment? What are they?
- (b) Identify the treatment structure of the experiment. Justify your answer.
- (c) Construct the complete Analysis of Variance table.
- (d) Test whether the effects of brands of generators and temperature at the location on the lifetime of generator are significant or not. Clearly state your findings.

- (6) An experiment was conducted to study the lifetime of four brands of tires (T_1 , T_2 , T_3 and T_4). There are 16 tires such that four tires from each brand are available for the study. The experimenter suspects that the lifetime of the tire can vary according to the type of the car used (*I*, *II*, *III* and *IV*) and the position of the tire on the car (*FL*, *FR*, *BL* and *BR*). To optimize the available resources, each brand of tire has been studied once for each type of car and once for each position of the tire on the car. The following are the data obtained from the experiment.

Car type	Tire position			
	<i>FL</i>	<i>FR</i>	<i>BL</i>	<i>BR</i>
<i>I</i>	$T_1=31$	$T_4=76$	$T_2=40$	$T_3=54$
<i>II</i>	$T_2=36$	$T_3=53$	$T_4=81$	$T_1=42$
<i>III</i>	$T_4=76$	$T_1=43$	$T_3=62$	$T_2=38$
<i>IV</i>	$T_3=60$	$T_2=41$	$T_1=45$	$T_4=84$

- (a) What type of an experimental design is this?

A part of the analysis is given below.

Source	Sum of Squares
Car type	108.19
Tire position	99.19
Brand	4478.69
Error	29.87
Total	4715.94

- (b) State the hypotheses that can be tested from this analysis, and test them.
- (c) Write down the conclusions that can be drawn from the analysis.
- (d) Find the Least Significant Difference (LSD) for comparing any two treatment means.
- (e) Hence or otherwise test whether brands of tyres T_1 and T_4 are equally effective. Clearly state the findings.