

EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE-2003/2004

(June/July'2005)

SECOND SEMESTER

ST 203 - DESIGN OF EXPERIMENT

Answer all questions

Time : Three hours

1. (a) Explain what do you understand by the term "Analysis of Variance". State the basic assumptions in an analysis of variance.
- (b) A farmer wants to test three different diets designed to maximize weight gain. The farmer randomly selects 12 pigs and divides them randomly into three groups of four pigs each. Each group is given one of the diets. The weight gain in pounds, after three weeks period are shown below.

Diet A	Diet B	Diet C
10.5	11.5	9.8
10.9	10.9	10.5
10.7	11.8	10.4
10.3	11.8	10.5

- i. Suggest a suitable model for this data.
- ii. Construct an ANOVA table.
- iii. Decide whether there is any difference in the weight among three types of diet at 5 % significance level.

2. (a) In a randomized block design where  $k$  treatments are to be compared in each of  $n$  blocks, express the total sum of squares

$$\sum_{j=1}^k \sum_{i=1}^n (X_{ij} - X_{..})^2$$

as the sum of three components. Identify the three terms in this equation and state (without proof) their distributions under appropriate hypothesis.

- (b) An experiment is conducted to investigate the yield of sugar cane. The following table gives the yield of sugar cane in metric tons, for each of the five varieties in four applications. In this experiment four plots of land were used and the five varieties were tested in each of these plots by subdividing each of the plots into five sub plots, with each of these five sub plots seeded by one of the varieties completely.

Plot	Variety				
	A	B	C	D	E
1	310	353	366	299	367
2	360	293	335	264	314
3	307	306	339	311	377
4	240	242	312	302	276

- Suggest a suitable model to analyze this data.
  - Construct the ANOVA table.
  - Test whether the varieties are equally good with respect to the yield and find the best variety if they are not equally good.
3. Four experiments determine the moisture content of samples of a powder; each man taking a sample from each of six consignments. The assessments are,



Consignment

Observer	1	2	3	4	5	6
1	9	10	9	10	11	11
2	12	11	9	11	10	10
3	11	10	10	12	11	10
4	2	11	11	14	12	10

Carry out the ANOVA and state your conclusions.

4. The data in the table shows below the times (in seconds) taken by 12 boys and 12 girls to solve a mathematical question. The boys and girls were categorized into three different groups of intelligence: Bright, Average, Dull. Four different boys/girls were used for each possible combination of intelligence and sex.

	Intelligence					
	Bright		Average		Dull	
Boys	34	16	107	101	130	110
	39	33	81	98	107	102
Girls	125	93	121	132	95	108
	127	89	156	138	98	134

$$\sum_i \sum_j x_{ij} = 2374$$

$$\sum_i \sum_j x_{ij}^2 = 264708$$

- Give a suitable model for these data, and explain the meaning of the terms.
- Compute the analysis of variance and interpret the results.
- Draw a simple diagram using the mean values for each combination to show the effects of sex, intelligence and their interaction.

5. (a) Explain what is meant by the terms “effect of a factor” and “interaction” in the content factorial experiment.
- (b) The lifetime of an electronic component in a standard test program depends on two factors involved in its manufacture:  $S$ , the source of supply of one of the raw materials and  $T$ , the temperature at which one part of the manufacturing process is operated. There are two sources of material ( $S_1$  and  $S_2$ ) and two temperatures ( $T_1 = 250^\circ C$  and  $T_2 = 300^\circ C$ ) and five components are available for each of the four combinations of levels of  $S$  and  $T$ . The components are tested in a randomized-block scheme, blocks being different days of starting the test. The lifetimes (hours) were as follows:

Levels of $S$	Levels of $T$	Day					Total
		$I$	$II$	$III$	$IV$	$V$	
$S_1$	$250^\circ C$	5.3	6.0	4.8	5.2	5.7	27.0
$S_1$	$300^\circ C$	10.9	12.5	11.2	10.1	11.5	56.2
$S_2$	$250^\circ C$	18.4	17.7	19.0	16.3	18.9	90.3
$S_2$	$300^\circ C$	28.7	26.6	27.5	28.0	27.5	138.3
	Total	63.3	62.8	62.5	59.6	63.6	311.8

The sum of the squares of all the observations,  $\sum y_i^2$ , is 6244.92.

- i. Carry out an appropriate analysis and report on its results.
- ii. Illustrate the results on a graph which shows the mean of each  $(S, T)$  combination and explain how the graph helps in understanding the results.

6. The five treatments are assigned in  $5 \times 5$  LSD as follows:

<i>B</i>	<i>A</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>C</i>	<i>D</i>	<i>E</i>	<i>B</i>	<i>A</i>
<i>E</i>	<i>C</i>	<i>B</i>	<i>A</i>	<i>D</i>
<i>D</i>	<i>B</i>	<i>A</i>	<i>E</i>	<i>C</i>
<i>A</i>	<i>E</i>	<i>D</i>	<i>C</i>	<i>B</i>

where *A*- no manure, *B*-Urea, *C*-farm yard manure urea, *D*-Ammonium sulphate and *E*-farm yard manure Ammonium sulphate are the treatments. The following yields in Kg's were received in sugar cane with the above design:

	1	2	3	4	5
1	47.8	49.1	38.1	41.1	47.2
2	45.4	55.1	43.2	42.6	47.3
3	46.0	46.3	43.2	43.2	47.0
4	51.3	42.3	32.6	44.2	49.3
5	52.5	40.9	48.2	54.3	46.8

(a) Analyze the above data.

(b) Construct the ANOVA table and test the treatment effects.