



EASTERN UNIVERSITY, SRI LANKA
SECOND EXAMINATION IN SCIENCE - (2007/2008)
FIRST SEMESTER (December/January, 2008)
ST 203 - EXPERIMENTAL DESIGN
(PROPER & REPEAT)

Answer all Questions

Time: Three hours

Q1. The following table shows the life of electric bulbs from four companies A,B,C,D.

Company	Life in burning hours					
A	1020	1010	1030	1000		
B	1030	1040	1030	1050	1060	
C	990	980	970	960	970	980
D	1040	1050	1070	1030		

- (a) Carry out the Analysis of Variance of these data. [60 marks]
- (b) State the assumptions you have made. [20 marks]
- (c) Explain your conclusion, about the life of electric bulbs from four companies. [20 marks]

Q2. (a) In a randomized block design where n treatments are to be compared in each of k blocks, express the total sum of squares

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

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

[50 marks]

- (b) The complete table below is the analysis of variance for the results of an experiment in which five treatments were compared in each of four randomized blocks.

S.V	d.f	S.S	M.S
Treatment	(a)	(e)	(h)
Blocks	(b)	(f)	1042
Error	(c)	(g)	200
Total	(d)	10030	-

- (i) Fill in the missing items (a), (b), (c),... (h) in the table and state the appropriate hypothesis. [35 marks]

- (ii) Is the blocking appropriate? [15 marks]

- Q3. (a) Write down the standard squares of 4×4 Latin Square Design. [20 marks]

- (b) The plan below is a Latin Square Experiment to test the efficiency of methods of dusting with sulphur in order to control stem rust of wheat. The key to treatments are given with plan shown in the following: Key to treatments

		Columns				
		1	2	3	4	5
Rows	1	B	D	E	A	C
	2	C	A	B	E	D
	3	D	C	A	B	E
	4	E	B	C	D	A
	5	A	E	D	C	B

A- Dusted before rains, B- Dusted after rains, C- Dusted once each weak, D- Drifting once each weak, E- Not dusted at all.

All applications were 30 bushels to the acre at each treatment. Drifting meant the Sulphur was allowed to settle over the plant from above. The plots yields

in bushels per acre are given below where the figures in the table correspond to the position of the plots and the treatments in the plan.

	1	2	3	4	5
1	4.9	6.4	3.3	9.5	11.8
2	9.3	4.0	6.2	5.1	5.4
3	7.0	15.4	6.5	6.0	4.6
4	5.3	7.6	13.2	8.6	4.9
5	9.3	6.3	11.8	15.9	7.6

(b) Analyze the data to find out if there are any treatment effects. [60 marks]

(c) Setup another similar field plan for this experimental design. [20 marks]

Q4. The data in the following table are from a randomized blocks experiment to learn the effects of two supplements to a corn ration for feeding pigs of both sexes. The factors were:

Lysine (L): 0 and 0.6%.

Soya bean meal (P): amounts added to supply 12% and 14% protein.

Sex (S): male and female.

Average dail gains of pigs in 2^3 - factorial arrangement of treatments in randomized blocks experiment are given below:

L %	M %	Sex	Blocks							
			1	2	3	4	5	6	7	8
0	12	M	1.11	1.09	0.97	1.21	1.29	0.85	0.96	0.99
		F	1.03	0.99	0.97	1.21	1.19	0.99	1.24	0.99
	14	M	1.52	1.27	1.45	1.24	1.34	1.67	1.32	1.22
		F	1.48	1.53	1.22	1.57	1.13	1.16	1.43	1.19
0.6	12	M	1.22	1.34	1.13	1.19	1.25	1.34	1.32	1.41
		F	0.87	1.16	1.00	1.14	1.36	1.00	1.32	1.29
	14	M	1.38	1.40	1.08	1.39	1.17	1.46	1.21	1.21
		F	1.09	1.47	1.09	1.17	1.01	1.24	1.13	1.43

Analyze the data and write a report on your findings.

[100 marks]

Q5. A manufacture wishes to determine the effectiveness of four types of machines M_1, M_2, M_3, M_4 in the production of bolts. To accomplish this, the number of defective bolts produced by each machine on the days of a given week are obtained for each of two shifts. The result is as follows:

		First Shift				
		Monday	Tuesday	Wednesday	Thursday	Friday
M_1		6	4	5	5	4
M_2		10	8	7	7	9
M_3		7	5	6	5	9
M_4		8	4	6	5	5

		Second Shift				
		Monday	Tuesday	Wednesday	Thursday	Friday
M_1		5	7	4	6	8
M_2		7	9	12	8	8
M_3		9	7	5	4	6
M_4		5	7	9	7	10

Perform an ANOVA table to test at 5% significance level, whether there is

(a) a different in machines.

(b) a different in shifts.

[100 marks]

Q6. The objective of an agriculture experiment was to determine whether appreciable differences occurred in the yield of wheat among four varieties and three types of fertilizers. For the experiment a large farm area was found whose conditions were nearly homogeneous. The farm was divided into twelve equal plots for the twelve combinations of variety and fertilizer type.

To measure the experimental error, each plot was divided into four sub-plots and all sub-plots within a main plot received the same treatment. The three kinds of fertilizer were randomly selected from a relatively large number of types of fertilizer; but insert doesn't extend beyond the four varieties of wheat selected for the experiment. At harvest time the yields in the table given below were observed.

		(in Kg per acre)			
		Wheat Variety			
		A	B	C	D
1		35	45	24	55
		26	39	23	48
		38	39	36	39
		20	43	29	49
Fertilizer 2		55	64	58	68
		44	57	74	61
		68	62	49	60
		64	61	69	75
3		97	93	89	82
		89	91	98	78
		92	82	85	89
		99	98	87	92

- (a) Write the appropriate model for this experiment. [25 marks]
- (b) State the hypothesis to be tested. [15 marks]
- (c) Determine the ANOVA table and draw the appropriate conclusion. [60 marks]