University of Ruhuna

Bachelor of Science Special Degree
(Level II) Semester I Examination - January 2021

Subject: Mathematics
Course unit: MSP4263 (Design and Analysis of Experiments)

Time: Two (02) Hours

Answer all Questions

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1. a) Explain how you would apply Scheffe's method in testing m contrasts on a completely randomized design with s treatments.

(40 marks)

b) An experimenter investigated the effects of 4 teaching methods on the efficiency of solving mathematical problems.
Students in a same grade and of almost equal knowledge in Mathematics were selected and students were assigned to 4 teaching methods randomly. Finally, a common problem was given to each individual student. While solving the problem the experimenter recorded the time (in minutes) spent by each student to solve the problem separately as shown below.

1^{st} Teaching method	10	15	8	12	15		
2^{nd} Teaching method	14	18	21	15			
3^{rd} Teaching method	17	16	14	15	17	15	18
4^{th} Teaching method	12	15	17	15	16	15	

Test whether $\mu_1 + \mu_3 = \mu_2 + \mu_4$ at 0.05 level of significance ; where μ_i denotes the mean solving time taken by students of i^{th} teaching method ; i=1,2,3,4.

(60 marks)

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2. Discuss the advantages and disadvantages of the Latin square design.
With the usual notation for a $p \times p$ latin square, find an unbiased estimator for α_i.

(30 marks)

a) An experimenter has discussed some instances of carefully planned investigations in market research. In each experiment of this series four merchandising practices A, B, C and D were compared and, since it was clearly desirable that each merchandising

Continued.

practice should be used in each store, it was decided to arrange the experiment to continue for a multiple of four time periods. The 16 experimental units were in the Latin square design and daily sales amounts (in kg) were recorded as shown below:

Time period	Store 1	Store 2	Store 3	Store 4
I	A 16.40	B 12.10	C 14.25	D 13.45
II	B 14.75	A 11.85	D 14.00	C 12.90
III	C 16.70	D 7.10	B 16.65	A 11.80
IV	D 15.65	C 12.90	A 16.65	B 6.60

Carry out the analysis of variance and make the relevant conclusions for the experiment at 0.05 significance level.

(50 marks)

b) Find 95% confidence interval for the difference between 2^{nd} store effect and 3^{rd} store effect.

(20 marks)

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3. For n replicated factorial experiment of 2 factors A and B, where the factor A is of a levels, and the factor B is of b levels, show that
$SS_T = SS_A + SS_B + SS_{AB} + SS_E$ with the usual notation.

(40 marks)

It is believed that the reaction time of children for different sounds, depends on two factors; age of the child (A) and the strength of the sound (B). Two replicates of a factorial experiment were run with 4 levels of age (A_1, A_2, A_3, A_4), and 3 levels of sound (B_1, B_2, B_3). The reaction time (in seconds) are as follows:

Levels	A_1	A_2	A_3	A_4
B_1	15	13	12	10
	12	8	11	11
B_2	12	14	11	15
	13	9	13	18
B_3	18	15	11	10
	13	16	12	10

Carry out the analysis of variance at 0.05 significance level.
After rejecting or accepting the null hypotheses, the interpretations of the results should be given.

(60 marks)

Continued.

4. a) For a 2^3 full factorial design of three factors A, B and C with n replicates, obtain the unbiased estimators for parameters μ, α_i, $(\alpha\beta)_{ij}$ and $(\alpha\beta\gamma)_{ijk}$ with the usual notation.

(30 marks)

b) The three factors iron, calcium and sodium were varied in a food. Each of these set at two levels ; high and low. The food was given for 16 low weight babies. After assigning treatments to the babies randomly, the number of weeks taken to increase the weight were recorded as below:

A - iron
B - calcium
C - sodium.

	A-low		A-high	
	B-low	B-high	B-low	B-high
c-low	1,2	2,3	3,4	2,2
c-high	2,3	4,4	2,2	6,8

Find all interaction effects.

(35 marks)

c) Describe how do you design $\frac{1}{2}$ replicate of 2^3 factorial design and discuss the advantages and disadvantages of the design.

(35 marks)
