UGANDA MARTYRS UNIVERSITY

FACULTY OF SCIENCE

UNIVERSITY EXAMINATIONS

Third Year Examination for Bachelor of Science General

Experimental Design and Industrial Statistical Modelling

Date: 17th, December, 2012
Time: 3 hours

Instructions

(i) Attempt Question 1 and any other four questions.
(ii) Question 1 is compulsory.

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Question 1 (Compulsory)

(a) Define the following terms as used in Experimental Design and Statistical modelling:

i) an experiment (2 marks)

ii) a treatment (2 marks)

ii) a covariate (2 marks)

(b) The Total sum of squares SST in the two-way ANOVA is given by

$$SST = \sum_i \sum_j \sum_k (y_{ijk} - \bar{y}_{+++})^2$$

Show that this is equal to

$$\sum_i \sum_j \sum_k {y_{ijk}}^2 - \frac{{y_{+++}}^2}{N}$$

(3 marks)

(c) Write a statistical model which can be used for each of the following experimental designs. (Clearly explain each term used)

i) Completely Randomised Design (2 marks)

ii) Latin Squares Design (2 marks)

With reference to these models explain why a statistician would prefer LSD over CRD. (1 marks)

(d) Using a suitable example explain how the analysis of covariance works in the field of Statistics.(You may include graphs) (6 marks)

Question 2

(a) State the underlying assumptions of the ANOVA. (2 marks)

(b) In a biological experiment, three concentrations of a chemical are used to enhance the growth of beans over a period of ten days. The following growth data in *cm* were recorded for the plants that survived.

concentration

1	2	3
8.2	7.7	6.8
8.7	8.4	7.3
9.4	8.6	6.3
	8.1	6.9
		7.1

Is there a significant difference in the average growth of these plants for the different concentrations of the chemical? Use $\alpha = 0.05$ (8 marks)

(c) The table below gives the yields in thousands of kgs/hectare of 3 varieties of beans grown using 4 different types of fertilisers.

		Varieties		
		V_1	V_2	V_3
	F_1	49	57	59
Fertilisers	F_2	40	42	32
	F_3	44	51	43
	F_4	43	42	

Assuming there is no interraction between the fertilisers and the varieties, test the hypotheses (at the 10% level of significance)

i) There is no difference in the average yield of beans when different kinds of fertilisers are used. (5 marks)

ii) There is no difference in the average yields of the 3 varieties of beans. (5 marks)

Question 3

(a) *In an experiment to study the effect of a fertilizer on the growth of tomato plants, four different fertilizers and one nursery bed are used.*
Explain each of the following terms as used in Experimental Design citing the application of each term in the experiment above.

i) Experimental unit (1.5 marks)

ii) Factor (1.5 marks)

iii) Treatment (1.5 marks)

iv) Placebo (1.5 marks)

(b) Explain the steps followed in designing an experiment. (8 marks)

(c) Write brief notes about the basic principles of experimental design. (6 marks)

Question 4

(a) State two advantages of the randomised block design over the completely randomised design. (2 marks)

(b) In a statistical experiment to compare three different varieties of wheat W_1, W_2 and W_3, it is known that the quantity harvested depends on the three different fertilisers used and the three different seasons S_1, S_2 and S_3. The data below are the yields of the varieties measured in *kgs* per plot.

	Fertiliser treatment		
Season	f_1	f_2	f_3
S_1	$W_1(60)$	$W_3(56)$	$W_2(49)$
S_2	$W_2(75)$	$W_1(49)$	$W_3(56)$
S_3	$W_3(58)$	$W_2(45)$	$W_1(29)$

Assuming that the various sources of variation do not interact, use a 10% level of significance to test the hypothesis that there is no difference in the average yield of wheat:

i) when different kinds of fertilisers are used; (6 marks)

ii) in the different seasons; (6 marks)

iii) for the three varieties of wheat. (6 marks)

Question 5

(a) A study on the academic performance of four students before (pre-test) and after (post-test) subjecting them to a teaching technique gave the following results.

	Student			
	A	*B*	*C*	*D*
pre − test	50	55	45	55
post − test	58	63	53	65

Using a 5% level of significance check whether or not the teaching technique was effective. (8 marks)

(b) The table below gives the quantity of eggs laid by 3 different hens being fed on 4 different types of feeds. .

		hens		
		h_1	h_2	h_3
Feeds	F_1	19	27	29
	F_2	10	12	2
	F_3	14	21	13
	F_4	13	12	y

The quantity y was lost in the process of carrying out the experiment.

i) estimate the value of y (6 marks)

ii) hence using a 5% level of significance test the hypothesis that there is no difference in the quantity of eggs laid when different feeds are used. (6 marks)

Question 6

(a) Outline five assumptions of the ANCOVA. (5 marks)

(b) A nutrition study was designed to compare the growth of children in three different environments U, V) and R. The following data were heights H (assumed growth indicater) of children in the three samples.

	Environment		
	U	V	R
	130	100	50
H in cm	135	90	45
	120	90	40

Analyse the data with a one-way ANOVA test and state the environment with the highest rate of growth using a 5% level of significance. (5 marks)

(c) In addition to part (b) above, the age X (years) of the children is shown in the table below.

	Environment		
	U	V	R
	8.0	4.0	1.0
X in years	8.0	5.0	2.0
	9.0	6.0	3.5

Analyse the observations in the table above and present the findings in an ANCOVA table using a 5% level of significance. (9 marks)
Comment about the accuracy of your results in part (b) in comparison to those of part (c). (1 marks)

END