

DEPARTMENT OF STATISTICS AND DEMOGRAPHY

MAIN EXAMINATION, 2012/13

**COURSE TITLE:** DESIGN AND ANALYSIS OF EXPERIMENTS

**COURSE CODE:** ST 404

**TIME ALLOWED:** TWO (2) HOURS

**INSTRUCTION:**

1. ANSWER ANY THREE QUESTIONS;
2. EACH QUESTION CARRIES 20 MARKS.

**SPECIAL REQUIREMENTS:** SCIENTIFIC CALCULATORS AND GRAPH PAPER

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**Question 1**

The following table presents scores of 9 college students of different ethnic backgrounds and professional interests who did a Mature Entry Aptitude test for admission to the University of Swaziland.

Programme	Swazi	South African	Zimbabwean
Agriculture	A (75)	B (86)	C (69)
Law	B (95)	C (79)	A (86)
Engineering	C (70)	A (83)	B (93)

The letter A, B, and C indicate venues in which the 9 students wrote. Analyse the data using  $\alpha=0.05$  and test the hypotheses that:

- Writing in different venues has no effect on the scores of students.
- Different ethnic background has no effect on the scores.
- Differences in professional interests have no effect on the scores. (20 marks)

**Question 2**

Four air conditioning compressor designs were tested in four different regions of Swaziland. The test was replicated by installing additional air-conditioners in a second cooling season. The following are times to failure (to the nearest month) for each compressor tested.

Design	Replicate 1				Replicate 2			
	A	B	C	D	A	B	C	D
Northeast	58	35	72	61	49	24	60	64
Southeast	40	18	54	38	38	22	64	50
Northwest	63	44	81	52	59	16	60	48
Southwest	36	9	47	30	29	13	52	41

Test at 5% level of significance whether the differences among the means for designs, regions and replicates are significant and for significance of the interaction between compressor designs and regions. (20 marks)

**Question 3**

- What is confounding? Explain the difference between a completely confounded and partially confounded experiment. (6 marks)
- When we say the higher-order interaction, say ABCDE is confounded with blocks, what do we mean? (4 marks)
- Use the linear combination method to construct two blocks of the  $2^3$  design with ABC confounded with blocks. Specify clearly the defining contrast corresponding to ABC. Which is the principal block. (10 marks)

**Question 4**

- (a) List the effects that can be estimated with a  $2^4$  factorial experiment. (4 marks)
- (b) An engineer wants to run a  $2^5$  factorial experiment in four blocks. Suppose that both ABCD and ACE are confounded with blocks.
- (i) Determine the generalized interaction (2 marks)
- (ii) Write down the treatment combinations for each of the four blocks. (8 marks)
- (c) In a  $2^5$  design with four blocks, the treatment combinations in the principal block are:
- (1) bc ae abd bde cde acd abce

Write out the treatment combinations in the other three blocks. (6 marks)

**Question 5**

There are various ways to bake a cake. An experiment was conducted to determine how pan material, the brand of cake mix and the stirring method affect the taste of cakes. The factor levels are:

Factor	Low (-)	High (+)
A = pan material	glass	aluminum
B = stirring method	spoon	mixer
C = brand mix	cheap	expensive

The response variable was taste, a subjective measure derived from a questionnaire given to the subjects who sampled each batch of cakes. An eight-person panel sampled each batch and filled out the questionnaire. The complete set of data is shown below:

Cake	A	B	C	Test Panel Results								Total
				1	2	3	4	5	6	7	8	
1	-	-	-	11	9	10	10	11	10	8	9	78
2	+	-	-	15	10	16	14	12	9	6	15	97
3	-	+	-	9	12	11	11	11	11	11	12	88
4	+	+	-	16	17	15	12	13	13	11	11	108
5	-	-	+	10	11	15	8	6	8	9	14	81
6	+	-	+	12	13	14	13	9	13	14	9	97
7	-	+	+	10	12	13	10	7	7	17	13	89
8	+	+	+	15	12	15	13	12	12	9	14	102
Total				98	96	109	91	81	83	85	97	740

- (a) Analyse the data from this experiment and draw conclusions. (20 marks)

**END OF EXAM!!**