UNIVERSITY OF ESWATINI

FIRST SEMESTER MAIN EXAMINATION PAPER, APRIL 2021

FACULTY OF SOCIAL SCIENCES

DEPARTMENT OF STATISTICS AND DEMOGRAPHY

COURSE CODE: STA407

TITLE OF PAPER: DESIGN AND ANALYSIS OF EXPERIMENTS

TIME ALLOWED: 3 HOURS

Instruction

1. Answer **any three** questions

Special Requirements

Scientific calculator

Additional Material (s)

1. Graph paper

*Candidates may complete the front cover of their answer book when instructed by the Chief Invigilator and sign their examination attendance cards but must **NOT** write anything else until the start of the examination period is announced.*

No electronic devices capable of storing and retrieving text, including electronic dictionaries and any form of foreign material may be used while in the examination room.

DO NOT turn examination paper over until instructed to do so.

QUESTION ONE [2+10+2+6]

The breaking strength of a fiber is required to be at least 150 psi. Past experience has indicated that the standard deviation of breaking strength is $\sigma = 3$ psi. A random sample of four specimens is tested. The results are $y_1 = 145$, $y_2 = 153$, $y_3 = 150$ and $y_4 = 147$.

(a) State the hypotheses that you think should be tested in this experiment.
(b) Test these hypotheses using $\alpha = 0.05$. What are your conclusions?
(c) Find the P-value for the test in part (b).
(d) Construct a 95 percent confidence interval on the mean breaking strength.

QUESTION TWO [14+6]

The tensile strength of Portland cement is being studied. Four different mixing techniques can be used economically. The following data have been collected:

Mixing Technique	Tensile Strength (lb/in^2)			
1	3129	3000	2865	2890
2	3200	3300	2975	3150
3	2800	2900	2985	3050
4	2600	2700	2600	2765

(a) Test the hypothesis that mixing techniques affect the strength of the cement. Use $\alpha = 0.05$.
(b) Use the Fisher LSD method with $\alpha = 0.05$ to make comparisons between pairs of means.

QUESTION THREE [20]

The effect of five different ingredients (A, B, C, D, E) on reaction time of a chemical process is being studied. Each batch of new material is only large enough to permit five runs to be made. Furthermore, each runs requires approximately 1 1/2 hours, so only five runs can be made in one day. The experimenter decides to run the experiment as a Latin square so that day and batch effects can be systematically controlled. She obtains the data that follow. Analyze the data from this experiment (use $\alpha = 0.05$) and draw conclusions.

Batch	Day				
	1	2	3	4	5
1	A = 8	B= 7	D = 1	C = 7	E = 3
2	C = 11	E = 2	A = 7	D = 3	B = 8
3	B = 4	A = 9	C = 10	E = 1	D = 5
4	D = 6	C = 8	E = 6	B = 6	A = 10
5	E = 4	D = 2	B = 3	A = 8	C = 8

QUESTION FOUR [10+6+4]

An engineer suspects that the surface finish of a metal part is influenced by the feed rate and the depth of cut. She selects three feed rates and four depths of cut. She then conducts a factorial experiment and obtains the following data:

Feed Rate (in/min)	Depth of Cut (in)			
	0.15	**0.18**	**0.20**	**0.25**
0.20	74	79	82	99
	64	68	88	104
	60	73	92	96
0.25	92	98	99	104
	86	104	108	110
	88	88	95	99
0.30	99	104	108	114
	98	99	110	111
	102	95	99	107

(a) Analyze the data and draw conclusions. Use $\alpha = 0.05$.

(b) Compute a 95 percent interval estimate of the mean difference in response for feed rates of 0.20 and 0.25 in/min.

QUESTION FIVE [6+4+10]

(a) What is confounding? Explain the difference between a completely confounded and partially confounded experiment.

(b) When we say the higher-order interaction, say ABCDE is confounded with blocks, what do we mean?

(c) 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

END OF EXAMINATION