**UNIVERSITY OF SWAZILAND**

**FINAL EXAMINATION PAPER**

**PROGRAMME:** B.SC. AG. ECON. & AGBMNGT. YEAR 3 (NEW PROG.)
B.SC. AN. SCI. YEAR 3 (NEW PROG.)
B.SC. AGRON. YEAR 3 (NEW PROG.)
B.SC. HORT. YEAR 3 (NEW PROG.)
B.SC. LWM YEAR 3 (NEW PROG.)

**COURSE CODE:** AEM 303

**TITLE OF PAPER:** AGRICULTURAL STATISTICS

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

**INSTRUCTIONS:**

1. ANSWER ALL QUESTIONS IN ALL SECTIONS.
2. ANSWER ALL QUESTIONS ON THE QUESTION PAPER. YOU DO NOT NEED AN EXAMINATION ANSWER FOLDER. SUBMIT THIS QUESTION PAPER. DO NOT REMOVE IT FROM THE EXAMINATION ROOM.
3. QUESTIONS CARRY MARKS AS INDICATED IN THIS PAPER.

Candidate's Examination Number :____________________.

Time of Examination :____________________.

Date of Examination :____________________.

Venue of Examination :____________________.

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**SECTION I: Multiple Choice:** For each item, circle the one letter corresponding to the choice that best completes/answers that item. Read all choices before you circle one.

(2 marks each) [50 marks total]

1. In reference to complete blocks being used to control experimental error:
   a. Variation among blocks can be estimated.
   b. Variation among blocks can be removed from experimental error.
   c. All treatments are applied to each block.
   d. a. and b. f. b. and c.
   e. a. and c. g. a., b., and c.

2. In the analysis of variance of a two-factor experiment carried out in a split-plot design, the F value for the whole-plot factor (Nitrogen) is significant, the F value for the sub-plot factor (Cultivar) is not significant and the F value for the Nitrogen X Cultivar interaction is significant. The final conclusions should be based on the mean separation test based on the:
   a. overall Nitrogen means. e. a. and c.
   b. overall Cultivar means. f. b. and c.
   c. Nitrogen X Cultivar interaction means. g. a., b., and c.
   d. a. and b. h. none of the above.

3. In the ANOVA described in the previous question (Question I.2.), which error term is used to calculate the F test for the Nitrogen X Cultivar interaction?
   a. whole-plot error (error (a)). c. error (a) and error (b)
   b. sub-plot error (error (b)). d. none of the above.

4. If two means are being compared by the t-test, and each mean is the mean of 12 observations, the degrees of freedom for finding the table t is:
   a. 24 d. 12 g. 2
   b. 10 e. 20 h. 11
   c. 22 f. 23 i. 1

5. Dr. Anderson gets a cv of 8.5% in his experiments and others doing similar experiments usually get a cv of about 12%. This indicates that the experimental precision in Dr. Anderson's experiments is:
   a. less than the precision of the other experimenters.
   b. the same as the precision of the other experimenters.
   c. greater than the precision of the other experimenters.
   d. none of the above.

6. After an experiment is carried out in the Randomized Complete Block (RCB) design, the relative efficiency compared with the Completely Randomized (CR) design is calculated as 1.35. Thus, the experimental precision of the RCB design is:
   a. 135% less than that of the CR design. e. 1.35% less than that of the CR design.
   b. 135% greater than that of the CR design. f. 1.35% greater than that of the CR design.
   c. 35% less than that of the CR design. g. 0.35% less than that of the CR design.
   d. 35% greater than that of the CR design. h. 0.35% greater than that of the CR design.

7. Which of the following is/are true about fractional factorials?
   a. They have bigger block size than corresponding complete factorials.
   b. They have less treatments than corresponding complete factorials.
   c. They are useful for experiments with five or more factors.
   d. a. and b. f. b. and c.
   e. a. and c. g. a., b., and c.

8. If 85% of the variation in yield is explained by its simple linear regression on applied P, this implies that:
   a. $R = 0.85$. c. $r = 0.85$
   b. $R^2 = 0.85$ d. $r^2 = 0.85$

9. Single degree of freedom contrasts can be used to make:
   a. all possible comparisons among the means in a experiment.
   b. between-group comparisons.
   c. within-group comparisons.
   d. a. and b.
   e. a. and c.
   f. b. and c.
   g. a., b., and c.

10. In a statistical model, an effect that might have the same levels if the experiment were repeated is referred to as:
   a. formal.
   b. formal.
   c. fixed.
   d. redundant.
   e. random.
   f. reserved.

11. The underlying assumptions of regression include the assumption(s):
   a. the variables have a bi-(multivariate)-variate normal distribution.
   b. the X's are measured without error.
   c. the Y's are a random sample at each level of X.
   d. a. and b.
   e. a. and c.
   f. b. and c.
   g. a., b., and c.

12. In an experiment designed to test the effect of applied N fertilizer on the yield of beans, yield is referred to as a/an:
   a. non-crop response variable.
   b. treatment variable.
   c. environmental variable.
   d. crop response variable.

13. A common violation/Common violations of the underlying assumptions of the ANOVA is/are:
   a. variance homogeneity.
   b. non-normal distribution of errors.
   c. independence of errors.
   d. a. and b.
   e. a. and c.
   f. b. and c.
   g. a., b. and c.
   h. none of the above.

14. In the analysis of variance, treatment and environmental effects are assumed to be:
   a. exponential.
   b. multiplicative.
   c. additive.
   d. a. and b.
   e. a. and c.
   f. b. and c.
   g. a., b., and c.
   h. none of the above.

15. Which of the following is/are true about missing value estimation?
   a. We loose one degree of freedom from the total and error for each missing value.
   b. It gives the true value we would have obtained from the experiment.
   c. It does not add new information.
   d. a. and b.
   e. a. and c.
   f. b. and c.
   g. a., b., and c.

16. The Kruskal-Wallis H test is the non-parametric equivalent of:
   a. one-way ANOVA.
   b. paired t-test.
   c. unpaired t-test.
   d. a. and b.
   e. a. and c.
   f. b. and c.
   g. a., b., and c.
   h. none of the above.

17. For data with heterogeneous variance and no functional relationship between the variance and the mean, which of the following is appropriate?
   a. square-root transformation.
   b. Partitioning of the error term.
   c. No corrective measure.
   d. Logarithmic transformation.
   e. Arc-sine transformation.

18. The covariate must be unaffected by the treatments if the analysis of covariance is being used to:

a. estimate missing data.
b. aid in the interpretation of experimental results.
c. control experimental error and adjust treatment means.
d. all of the above.

19. The Mann-Whitney U test is the non-parametric equivalent of:

a. one-way ANOVA.
b. paired t-test.
c. unpaired t-test.
d. a. and b.
e. a. and c.
f. b. and c.
g. a., b., and c.
h. none of the above.

20. To get the least soil heterogeneity in an experimental site, a researcher should:

a. choose flat areas instead of sloping areas.
b. choose areas fertilized at different rates in previous experiments instead of areas previously fertilized uniformly.
c. choose areas in the shade of trees.
d. a. and b.
e. a. and c.
f. b. and c.
g. a., b., and c.

21. The underlying assumptions of correlation include the assumption(s):

a. One variable is dependent.
b. The observations are drawn at random.
c. The X's are measured without error.
d. a. and b.
e. a. and c.
f. b. and c.
g. a., b. and c.

22. Which of the following is/are assumption(s) of regression:

a. The variables have a bi-(multi-) variate normal distribution.
b. The Y's are a random sample at each level of X.
c. The X's are measured without error.
d. a. and b.
e. a. and c.
f. b. and c.
g. a., b., and c.

23. Grouping of homogeneous treatments helps to avoid competition effects due to:

a. missing hills.
b. non-planted borders.
c. varietal competition.
d. a. and b.
e. a. and c.
f. b. and c.
g. a., b., and c.
h. none of the above.

24. In a field experiment, when off-type plants are noticed, the researcher should:

a. remove the off-type plants early in the growing season, and correct yield mathematically after harvest.
b. remove the off-type plants just before harvest, and correct yield mathematically after harvest.
c. treat the off-type plants as normal plants.

25. In developing countries of humid tropics, technology performance may be different in farmers' fields than in research stations, because:

a. crop yield is usually high in farmers' fields.
b. variability among farm conditions is low.
c. response to improved crop management is less favourable in farmers' fields than in research stations.
d. a. and b.
e. a. and c.
f. b. and c.
g. a., b., and c.

SECTION II. **Matching:** To the right of each description of data, circle the letter of one measure given below that is most appropriate for that data before an ANOVA is done.

(2 marks each) [10 marks total]

Measure:
a. logarithmic transformation.
b. partitioning of the error term.
c. arc-sine transformation.
d. square-root transformation.
e. no corrective measure.

1. Data with standard deviation proportional to the mean. a. b. c. d. e.
2. Percentage data in the range from 10% to 85%. a. b. c. d. e.
3. Data in which the variance tends to be proportional to the mean. a. b. c. d. e.
4. Data with heterogeneous variance and no functional relationship between the variance and the mean. a. b. c. d. e.
5. Data with normally distributed, independent errors, additive effects and homogeneous variances. a. b. c. d. e.

SECTION III.

1. Assume the yield of four cultivars of maize was studied in a completely random design with four replications, and that insects damage the plots in an irregular manner unrelated to the cultivars. Further assume that to take this damage into account an analysis of covariance is performed with yield as the variable of interest (Y), and insect damage as the covariate (X). Part of the analysis of covariance (ANCOVA) table is given below.

a. State the appropriate hypotheses: [4 marks]

$H_o$:

$H_a$:

b. Complete the ANCOVA table. [12 marks]

Effect of cultivar on the yield of maize

**ANCOVA Table:**

| Source of Variation | df | $SS_X$ | SCP | $SS_Y$ | Y Adjusted for X df | SS | MS | F | Table F 5% | 1% |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 3 | 2 | 7 | 50 | | | | | | |
| Error | 12 | 6 | 9 | 20 | | | | | | |
| Total | 15 | 8 | 16 | 70 | | | | | | |
| Treatment adjusted | | | | | | | | | | |

c. Conclude. [4 marks]

2. In 1951, J.S. Hart, a biologist, determined the cooling constants of ninenteen (19) freshly killed mice and those of the same mice reheated to body temperature. Given below are the differences between corresponding cooling constants (freshly killed minus reheated).

+2, -4, -6, +8, +10, -11, -12, +13, +22, -25, -33, +33, +41, -45, +45, +45, +81, +92, +139

(Source: Steel and Torrie. Second Edition. 1980. McGraw-Hill. Page 539.)

Use **Wilcoxon's Signed Rank test** to test the hypothesis that the cooling constant for reheated mice is the same as the constant for freshly killed mice. Write a conclusion for this test. [The appropriate table values are 46 (approx. 5%) and 32 (approx. 1%).] (Do not state the relevant hypotheses or accept/reject them.) [10 marks]

3. Assume that the simple correlation coefficient for 100 seed weight (g) and yield (metric tons/ha) is calculated as -0.707. Further assume that it is significantly different from zero (P<0.01). Interpret the meaning of the correlation coefficient. [Do not state or accept/reject the relevant hypotheses.]

[10 marks]

**Formulas and Half-formulas you may need.**

$$\Sigma Y^2 - \frac{(\Sigma Y)^2}{n}, \quad \Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{n}, \quad \frac{\Sigma xy}{\Sigma x^2}, \quad \frac{\Sigma xy}{\sqrt{(\Sigma x^2)(\Sigma y^2)}}$$

$$s^2_{y.x} = \frac{\Sigma y^2 - \frac{(\Sigma xy)^2}{\Sigma x^2}}{n-2}, \quad t_b = \frac{b}{\sqrt{\frac{s^2_{y.x}}{\Sigma x^2}}},$$

$$t_r = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}, \quad \Sigma\frac{(O-E)^2}{E}, \quad \Sigma\frac{(|O-E|-0.5)^2}{E}, \quad Adj.SS_Y = SS_Y - \frac{(SCP)^2}{SS_X}$$

**FOR EXAMINERS' USE ONLY :**

| Section | Internal Examiner | | External Examiner | |
|---|---|---|---|---|
| | Mark | Signature | Mark | Signature |
| I. | | | | |
| II. | | | | |
| III.1 | | | | |
| III.2 | | | | |
| III.3 | | | | |
| TOTAL | | | | |