JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF AGRICULTURAL AND FOOD SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN FOOD SECURITY

THIRD YEAR SECOND SEMESTER 2023/2024 ACADEMIC YEAR

SIAYA

COURSE CODE: AAE 5121

COURSE TITLE: Statistical Methods

STREAM: MSc Food Security and Sustainable Agriculture / MSc Agricultural Extension

DATE: **EXAM SESSION:**

TIME: 3.00 HOURS

Instructions:

1. Answer <u>ANY THREE</u> questions in the exam booklets provided.
2. Candidates are advised not to write on the question paper.

Question 1 (20 MARKS)

a) Define following terms **(3 Marks)**

   a. Central limit theorem
   b. Random sample
   c. Probability

b) Calculate the mean, median, mode, variance and standard deviation of variable that takes values as given below.

   110, 117, 128, 195, 95, 100, 175, 250 and 750 **(5 Marks)**

c) Selecting the proper diet for tilapia and other fish is an important aspect of cage fish farming in Lake Victoria. A researcher wishes to estimate the mean weight of tilapia maintained on a specific diet for a period of 6 months. One hundred tilapia are randomly selected from an artificial pond and each is weighed.

   i. Identify the population, the parameter of the population and the sample of of interest to the researcher. **(3 Marks)**

   ii. If the sample measurements are used to make inferences about certain characteristics of the population, why is a measure of the reliability of the inferences important?

(3 Marks)

d) Bayes' theorem for conditional probability states that if A is any event of non-zero probability that occurs with some E_i; (i = 1, 2, 3, …,n), then:

$$P(E_i|A) = \frac{P(A|E_i).P(E_i)}{\sum_{i=1}^{n} P(A|E_i).P(E_i)};\ \ i = 1, 2, 3, \ldots, n.$$

A farmer has three cattle breeds A, B and C that he can select to use for milk production. The chance of their selections is in the ratio 1 : 2 : 4. The probabilities that breed A, B and C can improve the farm milk production and profitability are 0.8, 0.5 and 0.3, respectively. If the change does not take place, use Bayes' theorem to find the probability that it is due to the selection of breed C.

(6 Marks)

Question 2 (20 MARKS)

A researcher is studying the conditions under which commercially raised shrimp reach maximum weight gain. Three water temperatures (25^oC, 30^oC, 35^oC) and four water salinity levels (10%, 20%, 30%, 40%) are selected for study. Shrimp are raised in containers with specified water temperatures and salinity levels. The weight gain of the shrimp in each container is recorded after a 6-week study period. There are many other factors that may affect weight gain, such as density of shrimp in the containers, variety of shrimp, size of shrimp, and type of feeding. The experiment is conducted as follows: Twenty-four containers are available for the study. A specific variety and size of shrimp is selected for study. The density of shrimp in the container is fixed at a given amount. One of the three water temperatures and one of the four salinity levels is randomly assigned to each of the 24 containers. All other identifiable conditions are specified to be maintained at the same level for all 24 containers for the duration of the study. Suppose that each treatment is assigned to two containers and that 40 shrimp are placed in the containers. After 6 weeks, the individual shrimp are harvested and weighed.

a) Describe the experimental design used in the study, including independent variable and the levels of each factor being manipulated and number of replications.

(4 marks)

b) Explain how ANOVA (Analysis of Variance) could be used to analyze the data collected from this experiment. State clearly the generalized linear model appropriate for the experimental design. **(6 Marks)**

c) What are the potential confounding variables (source of experimental errors) in this experiment, and how were they controlled? **(4 Marks)**

d) Describe the steps taken in analyzing raw data in research. **(6 Marks)**

Question 3 (20 MARKS)

a) Enumerate the key steps involved in hypothesis testing **(4 Marks)**

b) What is H_o and H_a? Enumerate the types of error associated accepting/rejecting either a true H_o and H_a**.** **(4 Marks)**

c) An NGO in Siaya County is promoting farmers adoption of velvet bean (*Mucuna pruriens*) as a cover crop and protein source to improve soil fertility as well as alleviate

malnutrition in the region. The NGO adopted farmer field schools (FFS) extension approach for the training of farmers on velvet bean production for 3 years. To test whether the extension approach was important factor in the adoption of the velvet bean adoption, the NGO collected adoption data from 13,465 farmers across the county. Among the sampled farmers, 683 out of 3220 (21.2%) of farmers trained through FFS adopted velvet production, while 1498 out of 10,245 farmers not trained through FFS adopted velvet production.

i. Formulate a hypothesis to test whether difference in adoption of velvet bean production can be attributed to FFS training. **(4 Marks)**

ii. Develop a 2x2 contingency table for the above data for two-sample test for binomial proportions. **(3 Marks)**

iii. Using the provided formulae for Yates-Corrected Chi-Square Test for 2×2 Contingency Table, test whether the adoption of velvet bean production is attributed to FFS training.

$$X^2 = \left(|O_{11} - E_{11}| - .5\right)^2 / E_{11} + \left(|O_{12} - E_{12}| - .5\right)^2 / E_{12} + \left(|O_{21} - E_{21}| - .5\right)^2 / E_{21} + \left(|O_{22} - E_{22}| - .5\right)^2 / E_{22}$$

(5 Marks)

Question 4 (20 MARKS)

	I	II	III	IV	V	VI	VII	VIII	IX	X
Fertilizer, g	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
Yield, kg	4.0	5.5	6.8	8.0	8.5	8.7	9.5	9.8	9.5	9.9

a) Describe the assumptions of regression analysis. (**3 Marks**)

b) Ten maize plants were randomly selected and treated weekly with a solution in which x g of nitrogen fertilizer was dissolved in fixed quantity of water. The yield of maize grain was recorded. The resulting data is shown in the following table.

i. Calculate the equation correlation coefficient. **(6 Marks)**

ii. Calculate the equation of the regression line. **(6 Marks)**

iii. Estimate the yield of the plant treated weekly with 3.3g nitrogen fertilizer.

(2 Marks)

iv. Give reason(s) why you cannot estimate the yield of the plant treated with 10g nitrogen fertilizer. **(1 Mark)**

END