GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENTS OF GEOMATICS AND SURVEYING

Probability and Statistics

EGS 1111

This examination paper consists of 5 pages

Date:	**September 2023**
Total Marks:	**100**
Time:	**2:30 hours**
Examiner's Name:	**Mr. M. Ndlovu**

INSTRUCTIONS

This paper consists of two SECTIONS. Answer ALL questions in SECTION A and ANY THREE questions in SECTION B.

Use of non-programmable calculator is permissible.

ADDITIONAL MATERIALS

- Graph paper.
- List of Formulae

SECTION A: Answer ALL questions [40].

A1. (a) Define the following terms

    (i) Random Variable [2]

    (ii) Fuzzy Number [2]

    (iii) Spatial Data [2]

(b) Suppose we flip a fair coin to obtain heads or tails.

    (i) Define the sample space and the possible outcomes. [2]

    (ii) Define events and the probabilities of each. [2]

A2. (a) Consider an RV uniformly distributed between a = 5 and b = 10.

    (i) Calculate the mean and variance. [5]

    (ii) Plot the pdf and cdf. [5]

A3. (a) Suppose that on the average we get 1/3 intense hurricanes out of the total Atlantic hurricanes in a season. Suppose a binomial distribution for the number of intense hurricanes in a season.

    (i) Calculate the probabilities of the possible values of the number
of intense hurricanes in a season of 2 hurricanes. [4]

    (ii) Calculate the uncertainty in (a) (i). [4]

    (iii) Calculate the standard deviation. [4]

(b) Is it true that covariance of X and Y is equal to variance of X
when X = Y? Explain why. [3]

A4. Suppose that the number of breakdowns in a Mine per month follows a Poisson distribution, and suppose that $P(X = 0) = 0.05$. Determine the variance and mean of X. [5]

SECTION B: Answer ANY three questions [60].

B5. (a) Monthly rainfall at a site is classified in two groups: one group for El Niño months and the other for La Niña months (defined according to sea surface temperature in the Pacific Ocean). We have 100 months for each group. The variance of each group is the same.

(i) Is it true that rainfall during El Niño is different to that during La Niña? [2]

(ii) What type of test would you run? [2]

(iii) What is H_0? [2]

(iv) Suppose you get a p-value = 0.045. What is the conclusion of the study? [2]

(b) Filabusi Hospital city provides one of the most comprehensive emergency medical services in Matebeleland South Province. Operating in a multiple clinics system with approximately 20 mobile medical units, the service goal is to respond to medical emergencies with a mean time of 12 minutes or less and standard deviation of 3.2 minutes. The director of medical services wants to formulate a hypothesis test with a .05 level of significance, to determine whether or not the service goal of 12 minutes or less is being achieved. [12]

B6. (a) At a site, monthly air temperature is normally distributed. It averages to 20°C with standard deviation 2°C.

(i) What is the probability that a value of air temperature in a given month exceeds 24°C? [3]

(ii) What is the probability that it is below 16°C or above 24°C? [4]

(iii) What is the probability that it is below 18°C or above 26°C? [4]

(b) Three forest cover types (palms, pines, and hardwoods) and three terrain types (valley, slope, and ridge). We want to see if forest cover is associated with terrain? You classify all available sites or regions and organize in a table.

(i) What is the name given to the table used for classification of all available sites? [1]

(ii) What test would you use? [2]

(iii) Suppose you run this test and get value for the statistic 10.64 and p-value = 0.0309.
State the Null hypothesis and report on your conclusion? [6]

B7. (a) What are the asumptions of Chi-Square Experiment? [4]

(b) State the mean for Chi-Square Experiment. [2]

(c) In 2021 the GIS research team at Gwanda State University performed a study the opinions of ArcGis use by students. The percentage distribution of their responses is shown in the following table.

Opinion	Percentage
A: GIS mapping is something that is just at its infancy, and its use will grow exponentially over the next few years	45
B: GIS mapping is something that most student and the staff members will use, but it will not move more into the mainstream	21
C: GIS mapping is already over, and it is time to find the next best thing	17
D: I do not know enough about GIS mapping to have an opinion	17

Recently (in 2022) 800 randomly selected students were asked the same question. The following table lists the number of students in this sample who gave each response.

Opinion	Frequency
A: GIS mapping is something that is just at its infancy, and its use will grow exponentially over the next few years	374
B: GIS mapping is something that most student and the staff members will use, but it will not move more into the mainstream	183
C: GIS mapping is already over, and it is time to find the next best thing	127
D: I do not know enough about GIS mapping to have an opinion	116

Test at the 2.5% level of significance whether the current distribution of opinions is different from that for 2022. [14]

B8. Ozone is an important urban air pollution problem when it occurs in excessive amount in the lower troposphere. Its concentration relates to meteorological variables show in table below:

Ozone y	Solar R. x_1	Wind x_2	Temp x_3	Month x_4	Day x_5
41	190	7.4	25	5	1
36	118	8.7	32	5	2
12	149	9.4	28	5	3
18	148	12.6	33	5	4
NA	313	11.5	30	5	5
28	NA	14.3	32	5	6

Perform a multivariate analysis (multi-linear regression analysis) and obtain the coefficients on the model:

$$y = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 + a_5 x_5$$

[20]

B9. (a) Suppose all the data point are along the same line and there are equally spaced

u	1	2	3	4	5	6	7	8	9	10
$Z(u)$	41.2	40.2	39.7	39.2	40.1	38.3	39.1	40.0	41.1	40.3

with the variogram given by:

$$\gamma(h) = \frac{1}{2N(h)} \sum_{u_i - u_j = h} \big(Z(u_i) - Z(u_j)\big)^2$$

(i) Complete the following table giving your value to 2 decimal places:

h	1	2	3	4	5	6
$\gamma(h)$						

[12]

(ii) Plot the variogram using the data in (i). [5]

(iii) Comment on the theoretical variogram model that can be fitted from the information obtained in (i) and (ii) above. [3]

END OF QUESTION PAPER