ALUPE UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR

ACADEMICS, RESEARCH AND STUDENTS AFFAIRS

UNIVERSITY EXAMINATIONS

2024/2025 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER REGULAR MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE IN APPLIED STATISTICS AND COMPUTERING

COURSE CODE: STA 421

COURSE TITLE: STATISTICAL COMPUTING

DATE: 15TH JANUARY 2025 **TIME: 2.00PM – 5.00PM**

INSTRUCTION TO CANDIDATES

- SEE INSIDE

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REGULAR-MAIN EXAM

STA 421: STATISTICAL COMPUTING

STREAM: NLR2 **DURATION: 3 Hours**

INSTRUCTION TO CANDIDATES

Answer **ALL** questions from section A and any **THREE** from section B.

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SECTION A [31 Marks]. Answer ALL questions.

QUESTION ONE [15 Marks]

a) Briefly explain simulation in statistical computing and give its main application **(3marks)**

a) Explain the meaning between of the terms below, as the case may be:

i. Error analysis **(1 Mark)**

ii. Absolute Error **(1Marks)**

iii. Pseudo-Random Number Generator **(1Marks)**

iv. Confidence Interval **(1 Mark).**

b) Suppose E(X)=1 , E(Y)=3, E(X^2)=10, E(Y^2)=13, and E(X, Y)= 4,. We randomly sample n=9 times from and define $\overline{X} = \frac{1}{9}\sum_{i=1}^{9} X_i$. Calculate ;

i) E(2X+5Y) **(2 Marks)**

ii) VAR(X) and σ_X **(2 Marks)**

iii) E($\bar{X}$) and $\sigma_{\bar{X}}$ **(2 Marks)**

iv) Var (Y) and σ_Y **(2 Marks)**

v) Cov(X,Y) **(2 Marks)**

QUESTION TWO [20 Marks]

a) Define the following terms:

i)) Mean (expected value) of a random variable. **(2 marks)**

ii) Standard deviation of a random variable. **(2 marks)**

b) The following figures show the distribution of digits in numbers chosen at random from a telephone directory. Calculate the mean and standard deviation of the random variable.

(7 marks)

Digits	0	1	2	3	4	5	6	7	8	9	Total
Frequency	1026	1107	997	966	1075	933	1107	972	964	853	10,000

Calculate the mean and standard deviation of the random variable X.

c). Discuss the key differences between discrete and continuous distributions, focusing on their properties and applications. **(3 marks)**

c) Discuss the importance of generating random variates in statistical simulations and modelling and provide examples of applications where random variate generation is crucial. **(6 marks)**

SECTION B [39 Marks] Answer any THREE questions]

QUESTION THREE [13 MARKS]

Consider a discrete random variable X that follows a binomial distribution with parameters n and p, where n is the number of trials and p is the probability of success in each trial.

a) i)Calculate the mean and variance of the binomial distribution. (4 marks)

ii) If you were to standardize the variable Y, what transformation would you apply, and what would be the resulting distribution? (4 marks)

a) Let X be a continuous random variable with PDF (5marks)

$$f_x(x) = \begin{cases} 4x^3 & 0 < x \leq 1 \\ 0 & otherwise \end{cases}$$

Find $P(X \leq \frac{2}{3} | X > \frac{1}{3}$

QUESTION FOUR [13 MARKS]

a) Let X be a random variable with PDF given by

$$f_x(x) = \begin{cases} cx^2 & |x| \leq 1 \\ 0 & otherwise \end{cases}$$

i) Find the constant c *(3marks)*

ii) Find EX and Var(X) *(3marks)*

iii) Find $P(X \geq \frac{1}{2})$. *(3marks)*

b) Calculate a confidence interval for the mean of a normally distributed population based on a sample of size n = 30 with a sample mean of $\bar{X} = 50$ and a sample standard deviation of s = 5.Compute the confidence interval at a significance level of $\alpha = 0.05$ (4marks)

QUESTION FIVE [13 MARKS]

a) Explain two methods for generating random variates from a uniform distribution and describe how these methods can be extended to generate random variates from other distributions (e.g., exponential or normal distributions). (4 marks)

b) An automobile production lines turns out about 100 cars a day but deviation occur owing to many causes. The production is more accurately described by the probability distribution below. 9marks

Production per day	Probability
95	0.03
96	0.05
97	0.07

98	0.10
99	0.15
100	0.20
101	0.15
102	0.10
103	0.07
104	0.05
105	0.03

Finished cars are transported across the bay at the end of each day by a ferry. If a ferry has space for only 101 cars. What will be the average no. of cars waiting to be shipped and what will be the average no. of empty space on the ship. Use random nos. 97, 02, 80, 66, 96, 55,50, 29,58 51, 04, 86, 24, 39, 47.

QUESTION SIX [13 MARKS]

a) Briefly elaborate 2 applications of simulation (2 Marks)

b) A tourist car operator finds that during the past months the cars use has varied so much that the cost of maintaining the car varied considerably. During the past 200 days the demand for the car fluctuated as per the table below.

Trips per week	Frequency
0	16
1	24
2	30
3	60
4	40
5	30

Simulate the demand for-10 week period. Use the random Nos. 82, 96, 18, 96, 20, 84, 56, 11, 52, 03 (7marks)

c) State and explain the steps involved in a simulation study (4 Marks)

QUESTION SEVEN [13 MARKS]

a) Using LCG, generate a sequence of random numbers with x_0=73 ,a=2, c= 5 ,m=123 (5mark)

b) Describe the steps in performing a Monte Carlos simulation. (8 marks)