SAVIO HIGH SCHOOL, WAKISO

S.5 END OF YEAR 2025

425/1 APPLIED MATHEMATICS

2HR:40MIN

INSTRUCTIONS

This paper consists of two sections **A** *and* **B***.*

Section **A** *has* **two compulsory** *items and section* **B** *has* **two** *parts* **I** *and* **II***, respond to only one item in each.*

Response to each item **should** *be written on a* **black new page**

Neat *and* **organized** *responses are emphasized.*

Non-programmable *calculator and a* **mathematical table** *are accepted while in the examination.*

Section A

Attempt **all** *items in this section*

Item 1

You are part of a city traffic planning committee tasked with analyzing the daily number of cars passing through a busy checkpoint over 32 days. The data collected is grouped into intervals showing the number of cars per day and the days observed in each range.

Number of cars	-10	-20	-30	-40	50	-60
Number of days	2	10	6	10	4	0

Your goal is to help the committee understand traffic patterns for better planning.

Task.

a) Construct a histogram based on this 32-day data, use it to estimate the most cars passing through the checkpoint, hence describe what your value means about the traffic flow.
b) Calculate the average and variance of the number of cars passing through the checkpoint hence guide the committee on the significance of variance for traffic variability.
c) Construct a 95% confidence interval for mean daily number of cars.
d) How confident can the city planners be about future traffic volumes based on your result in (c).

Item 2

The united youth sports club is holding a fundraising raffle. A large prize drum contains a mix of sports balls. 30 tennis balls, 25 pool balls and 20-foot balls. In the main raffle event, three balls are drawn from the drum one after the another without replacement. For any ball randomly picked has a tagged prize on it so the after the raffle, prizes will be revealed and used to earn cash that will be used to develop the club.

Alongside the raffle, the club runs a daily mini game where 8 tickets are randomly selected each day from a large pool of tickets. Assume 30% of all tickets are winning tickets. The winning tickets picked by the members of the club can be used to get lunch from a surprise restaurant that day.

Task

a) Determine the probability of selecting 2 tennis balls
b) Construct a probability distribution table for the number of pool balls selected.

c) State with reasons whether the selection made in the daily mini game follows a binomial experiment and hence;
   i) Write the probability mass function for winning tickets drawn each day.
   ii) Find the probability of selecting at least 3 winning tickets.
   iii) Find the expected number of winning tickets per day and hence determine the deviation from the mean.

Section B

Part I

Attempt *any* **one** *item from this part*

Item 3

A home owner is getting a quote for a house wiring installation. The technician provides the following estimates, which have been rounded after calculations.

Length of wires needed is 103.8m

Cost of a meter of wire UGX 3500.52

Amount needed for wires and installation UGX 544950.526

The values **103.8**, **544950.526** and **3500.52** are all rounded to the given number of decimal places by the technician.

The technician needs to provide the quote to the home owner after analyzing all the areas that may be in his estimations.

Task

Help the technician

a) Determine the maximum possible error in the wire length, cost of a meter of wire and amount the technician needs for wires and installation.
b) Find the relative error in the total cost for the length of wire needed before installation correct to three decimal places.
c) The net salary for the technician is the difference between the “amount needed for wires and installation” and “total cost of the length of wire needed”. Determine the range within which the net salary lies correct to two decimal places.

Item 4

Mama Naki runs a successful juice stall in Wandegeya market. She is experimenting with a new passion fruit and tamarind juice blend. The sweetness of the mix depends on the number of spoons of sugar, x, she adds per liter. Her family taste testers describe the sweetness balance by the function $S(x) = x^3 + 2x - 1$.

A sweetness value $S(x) = 0$ represents the perfectly balanced flavor. A negative value means the juice is too sour, and a positive value means it is too sweet, she is trying to find the perfect number of sugar spoons between 0 and 1 that she needs to use.

She has come to you for help

Task

a) Show her that there is a perfect balance between adding 0 to 1 spoon of sugar per liter and use your knowledge of linear interpolation once to find an estimate of the perfect sugar amount. Report your answer correct to two decimal places.
b) To consistently make the perfect juice, she needs more precise measurement for final recipe standardization. Use the newton Raphson iterative method and your approximate value from (a) as the starting point, calculate the perfect number of sugar spoons correct to two decimal places.

Part II

Attempt only **one** *item from this part*

Item 5

A team of environmental scientists needs to cross a wide river to collect water samples from the opposite bank as quickly as possible. The river is 500 m wide and flows steadily eastwards at 4m/s. their motorboat can travel at 6m/s in still water.

However, midway across, they sight another research boat (boat B) collecting samples 400 meters further downstream, which after completing its task, starts moving directly north (across the river) at 5m/s to return to its own starting point. Both crews need to avoid colliding or interfering with each other's routes for accurate sampling and safety.

Task

a) As the lead navigator, determine;
   i) In what direction (relative to north) should your teams' boat be steered to cross the river in the shortest possible time?

ii) How long will the crossing take and what will be the actual distance covered by your boat.

b) After you start. Boat B begins moving north words from downstream location at the speed given.
   i) Calculate the closest distance that will occur between your boat and boat b during crossing.
   ii) At what time after departing do the two boats reach this minimum distance

Item 6

A team of technicians is installing a large metallic square **ABCD** for a roadside billboard. To stabilize the frame while welding, ropes are tied along its sides and diagonal. At the same time, a system of connected tool containers is suspended from one corner of the frame using light inextensible ropes and small pulleys. The four stabilizing ropes pull the frame as follows;

Rope **AB** pulls with **2N** from **A** towards **B**, Rope BC pulls with **1N** from **B** towards **C**, Rope **AC** pulls with $\sqrt{2}$**N** from **A** towards **C**, Rope **DA** pulls with **4N** from **D** towards **A**

The engineers need to know the overall stabilizing effect of these pulls.

At point B, a small, smooth pulley is fixed to the frame. Two tool containers, mass 3kg and mass 2kg, are connected by a light rope passing over the pulley. The 3kg container hangs on the outside of the frame. The 2kg container hangs on the inner side of the frame near point C. when released from rest, the system accelerates.

As the connected masses move, they exert additional forces on the frame through the pulley at B, affecting the stability. Assume the rope is light and inextensible, the pulley is smooth and use $g=9.8m/s^2$.

Task

Help the engineers determine the;

a) i) Resultant force magnitude due to the four stabilizing ropes acting on the frame.
   ii) Angle the resultant makes with side AB on the frame.

b) i) Acceleration of the 3kg-2kg connected system
   ii) Tension in the rope connecting the two masses
   iii)The tension acts on the pulley at B. convert this tension into horizontal and vertical components that act on the frame and determine the new overall resultant force acting on the frame
   iv)State whether the additional load from the connected masses will stabilize the frame.