

P425/2
APPLIED MATHEMATICS
Paper 2

END OF YEAR EXAMINATIONS
Uganda Advanced Certificate of Education
APPLIED MATHEMATICS
Paper 2
3 hours

INSTRUCTIONS TO CANDIDATES:

- *This paper consists of **two** Sections; **A** and **B**. Section **A** is **compulsory**, Answer only **four** questions from Section **B**.*
- *Any additional questions(s) answered will **not** be marked.*
- *All necessary working **must** be shown clearly.*
- *Begin each answer on a fresh page.*
- *Graph paper is provided.*
- *Silent, non-programmable scientific calculators and mathematical tables with a list of formulae may be used.*
- *In numerical work, take acceleration due to gravity g , to be 9.8 ms^{-1} .*

SECTION A

1. One end of a light inextensible string of length 75cm is fixed to a point on a vertical. A particle of mass 12kg is attached to the other end of the string. The particle is kept in equilibrium 21cm away from the pole by a horizontal force, F Newtons. Find the;
 - a) Tension in the string
 - b) Magnitude of F

2. Use the trapezium rule with 6 ordinates to estimate $\int_0^2 \frac{1}{\sqrt{1+x^2}} dx$ correct it to 3 decimal places.

3. Given that A and B are independent events in a sample space that $P(A) = \frac{3}{5}$ and $P(A \cup B) = \frac{4}{5}$. Find the;
 - a. P(B)
 - b. $P(A' \cup B')$

4. The table below shows the cost (y) in shs for hiring a motorcycle for a distance (x) in km

Distance (<i>x km</i>)	10	20	30	40
Cost (<i>y shs</i>)	2,800	3,600	4,400	5,200

Use either linear interpolation or extrapolation to estimate

- (a) Cost (y), when the distance (x) is 45km
 - (b) Distance (x), when the cost (y) is 14,000 shs
5. A lorry travels distances of 25.6m and 32m in the fourth and eighth seconds of its motion respectively. Determine the;
 - a. Initial velocity
 - b. Acceleration
6. The table below represents marks for ten students in mathematics and English of a certain school

English(x)	40	90	54	32	80	65	55	48	55	30
Mathematics(y)	68	40	47	64	55	41	62	76	74	80

Calculate the rank correlation coefficient and comment at 5% level of significance

7. A mass of 5kg is suspended in equilibrium by two light inextensible strings which make angles of 30° and 45° with the horizontal. Calculate the tensions in the strings.
8. A certain frequency distribution table with standard deviation 2.5 has the following results; $\sum f = n$, $\sum fx = 177$ and $\sum fx^2 = 5259$. Find the value of n

SECTION B

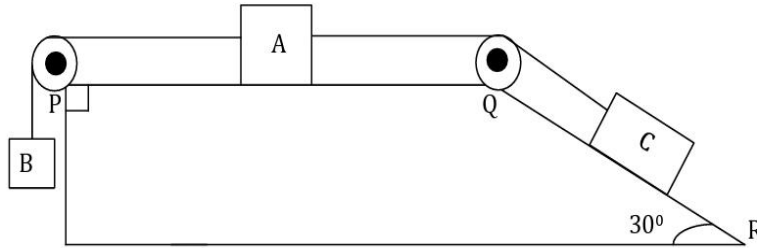
9. A factory uses a high precision machine to manufacture components. The machine has two critical settings, A and B which can be optimally calibrated to reduce defects. Based on historical data, the quality control engineer has determined the following probabilities. The probability that setting A is correctly calibrated is $P(A) = \frac{3}{5}$. If setting B is correct, the probability that setting A is also correct is $P(A/B) = \frac{5}{7}$. If setting A is correct, the probability of setting A is also correct is $P(B/A) = \frac{2}{3}$.

TASK

As a student of mathematics, help the factory determine,

- i. Probability of A and B, $P(A \cap B)$
 - ii. Probability of B, $P(B)$
 - iii. $P(A/\bar{B})$
- b) state with reasons whether A and B are,
- i. Independent events
 - ii. Mutually exclusive events.
10. A medical researcher is studying the concentration of a new drug in a patient's bloodstream. The concentration f (in mg/L) at a time t (in hours) after administration is modeled by the function $f(t) = e^t + t - 4$. The researcher needs to determine the exact time t when the drug concentration reaches a critical therapeutic level of 4mg/L. this is found by solving the equation:
 $e^t + t - 4 = 0$.
- ### TASK
- a) Using a suitable graph, show that the equation $e^t + t - 4 = 0$. Has a root between $t = 1$ and $t = 2$ hours. Your demonstration should be correct to 1 decimal place.
 - b) Using Newton Raphson Method with an appropriate starting value obtained from the graph, determine the time when the drug concentration hits 4mg/L. correct your answer to 3 decimal places.
 - c) Construct a detailed flow chart for a computer program that will read the initial approximation of time, t_0 , use the iterative formula derived above to compute better root to 3 decimal places and prints the root.
11. At a mountain road construction site, a temporary elevator system is used to transport materials between two levels. The system uses a

motorized pulley, P and a counter weight system for safety as show in the support material below.



Given that mass of A is 200kg and it is resting on a rough concrete of coefficient of friction 0.5, mass of B is 150kg and mass of C is 300kg resting on a smooth rail. Assume that the system is released from rest such that B moves upwards.

The block C is now placed on a rough inclined plane of inclination 30° to the horizontal of coefficient of friction 0.25.

TASK.

Help the engineers to determine

- a) Acceleration of the system and tensions in the strings connecting B to A and A to c
- b) The horizontal force required to prevent the block c from slipping down the plane.

12. In a physics laboratory at Makerere University, students were tasked with calculating the uncertainty in derived quantity $z = x\sqrt{y}$, where x and y are measured quantities with uncertainties Δx and Δy . The Expression for the maximum relative error in the function is given by $\left| \frac{\Delta x}{x} \right| + \frac{1}{2} \left| \frac{\Delta y}{y} \right|$. Given that $x=14.2$ $y=8.28$ and $w=5.332$,

TASK

Help the students to,

- i. Show clearly how the expression for the maximum possible relative error comes about
 - ii. Calculate the errors in x, y and w
 - iii. Determine the range of values within which the exact value of $xy + \frac{y}{w}$ lies, correct to 3 decimal places
 - iv. Calculate the absolute error in $xy + \frac{y}{w}$
13. The marks of S.5 students in a given mathematics test were summarized as shown in the table

Marks	Frequency
$0 < x \leq 10$	3
$10 < x \leq 20$	6
$20 < x \leq 30$	9
$30 < x \leq 40$	10
$40 < x \leq 50$	12
$50 < x \leq 60$	18
$60 < x \leq 70$	14
$70 < x \leq 80$	11
$80 < x \leq 90$	7

The head teacher of the school wanted to interpret the results so as he can make a general report about the general performance of the learners basing on the average mark, modal mark median mark and the standard deviation, but he doesn't know how best find them sine he is a History Teacher.

TASK

As a mathematics student, help the head teacher;

- (a) Calculate the;
 - i. Average mark
 - ii. Modal marks
 - iii. Standard deviation
- (b) Construct an ogive curve and use it to estimate median mark

14. The mechanical engineering students at Makerere university were tasked to design a model that will be used to build a pulley system machine used in machinery and industries. The model should comprise of a fixed pulley carrying a string which has a mass of 4kg attached at one end and a light pulley, A attached at the other end. Another string passes over pulley A and carries a mass of 3kg at one end and a mass of 1kg at the other end. Your friend has approached you for help on how to design it,

TASK

As a mathematics student, help your friend to;

- i. Find the acceleration of pulley A
- ii. Acceleration of the 1kg, 3kg and 4kg masses
- iii. The tensions in the strings to be used

END