

P425/2
APPLIED MATHEMATICS
PAPER 2
July/August 2024
3 hours



WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

APPLIED MATHEMATICS

Paper 2

3 hours

INSTRUCTIONS TO CANDIDATES:

- Attempt **all** questions in section **A** and any **five** questions from section **B**.
- Any additional question(s) answered will **not** be marked.
- **All** working must be shown clearly.
- Begin each answer on a fresh sheet of paper.
- Silent non programmable scientific calculators and mathematical tables with a list of formulae may be used.
- In numerical work, take g to be 9.8ms^{-2} .
- State the degree of accuracy at the end of the answer to each question at using a calculator or table and indicate **Cal** for calculator, or **Tab** for mathe tables.

Answer all questions in this section.

1. Two events A and B are such that $P(A) = \frac{1}{2}$, $P(A \text{ or } B \text{ but not both } A \text{ and } B) = \frac{1}{3}$ and $P(B) = \frac{1}{4}$. Calculate:
- (a) $P(A \cap B)$ (03 marks)
- (b) $P(B/A)$ (02 marks)
2. In an examination, scaling is done such that a student K whose original mark is 35% gets 50% and student N whose original mark is 40% becomes 65%. Determine the;
- (a) original mark for student M whose new mark is 80%
- (b) new mark for a student whose mark is 37% (05 marks)
3. A particle moving in a straight line covers distances of 90 meters and 240 meters in successive times of 2 seconds and 4 seconds respectively. Find the;
- (a) acceleration of the particle
- (b) initial velocity of the particle. (05 marks)
4. A discrete random variable y has a probability density function (p.d.f) given as:
- $$P(y = y) = \begin{cases} Ky^2; & y = 1, 2, 3 \\ K(y+1); & y = 4, 5 \\ 0 & , \text{ otherwise} \end{cases}$$
- Determine the;
- (a) value of constant K
- (b) mean of y
- (c) $P(2 < y \leq 4)$ (05 marks)
5. The pressure (P), absolute temperature (T) and volume (V) of a fixed mass of a gas is given by the following relationship: $P = \frac{KT}{V}$, where K is the constant of proportionality. If e_1 and e_2 are the errors made in measuring the absolute temperature and volume respectively, show that the maximum possible relative error made in pressure is $\left| \frac{e_1}{T} \right| + \left| \frac{e_2}{V} \right|$ (05 marks)
6. A football striker took a free kick with a velocity of 21 ms^{-1} at 30° above the horizontal. The defender intercepted it with a header at a height of 3 m above the ground. Calculate the speed of the ball at impact. (05 marks)

The price relatives for the years 2000 and 2004 and their weights of a house hold expenditure on essential goods are given in the table below.

Item	Price Relatives		Weight
	2000	2004	
Food	100	125	35
Water	100	121	11
Rent	100	112	8
Electricity	100	108	6
Transport	100	118	22

Calculate the:

- cost of living index for 2004. Comment on your results. (03 marks)
- cost of a cloth in 2004 that cost UGX 11,200 in 2000. (02 marks)

8. A particle executing simple harmonic motion about a point O has speeds of $3\sqrt{3} \text{ ms}^{-1}$ and 3 ms^{-1} when covering distances 1m and 0.268 m respectively from the end point. Find the amplitude of the motion. (05 marks)

SECTION B (60 MARKS)

Answer any **five** questions from this section.

All questions carry equal marks.

9. At 7:30a.m daily, a bus leaves Kampala for Jinja. The times (minutes) taken to cover the journey were recorded over a certain period of time shown in the table below:

Time(min)	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119
Frequency	10	15	35	40	28	15	4	3

- (a) Calculate the;

- Mean time of travel from Kampala to Jinja by the bus.
- Median time of travel

(07 marks)

- Draw a cumulative frequency curve. (Ogive) for the data.
 - Use the Ogive to estimate the number of times the bus arrived in Jinja between 9:00a.m to 9:25a.m

(05 marks)

10. (a) A square lamina ABCD of side 2M is made of uniform thin material. When a semi-circular piece with AB as its diameter is removed from square, show that the centre of mass of the remaining lamina is at a distance $\frac{20M}{3(8-\pi)}$ from the line AB. (07 marks)
- (b) The remainder of the lamina is suspended from a light string attached to C and hangs in equilibrium. Show that CD is inclined to the down ward vertical at angle α where; $\tan \alpha = \frac{2(14-3\pi)}{3(8-\pi)}$ (05 marks)

11. (a) Use the trapezium rule with 6 ordinates to estimate the values of

$\int_1^2 \left(\frac{x}{7x^2-3} \right) dx$, correct to four significant figures. (05 marks)

- find the exact value of $\int_1^2 \left(\frac{x}{7x^2-3} \right) dx$, correct four significant figures.
 - Calculate the percentage error in your calculation in (a) above.
 - Suggest how the percentage error may be reduced.

12. ✓ Box X contains 4 red battons and 3 green battons. Box Y contains 5 red and 6 green battons. Box X is twice as likely to be picked as box Y. A box is chosen at random and two battons are removed from it at a time without replacement.
- (a) Find the probability that the two battons removed are of the same colour. (05 marks)
 - (b) Construct the probability distribution table for the number of red battons picked. (04 marks)
 - (c) Calculate the mean number of red battons. (03 marks)
13. A particle moving with an acceleration given by:
- ✓ $\mathbf{a} = (4e^{-3t} \mathbf{i} + 12 \sin t \mathbf{j} - 7 \cos t \mathbf{k}) \text{ ms}^{-2}$ is initially located at the point $(5, -6, 2)$ and velocity $\mathbf{V} = (11 \mathbf{i} - 8 \mathbf{j} + 3 \mathbf{k}) \text{ ms}^{-1}$
- Find the;
- (a) magnitude of the acceleration when $t = 0$. (02 marks)
 - (b) velocity at any time t seconds. (04 marks)
 - (c) displacement at time $t = 1$ second. (06 marks)
14. ✓ (a) Use a graphical method to show that the equation $e^x + x - 4 = 0$ has only one real root. Hence obtain to one decimal place, an approximate root of the equation. (06 marks)
- (b) (i) Show that the Newton Raphson formula for estimating the root of the equation $e^x + x - 4 = 0$ is given by $x_{n+1} = \frac{e^{x_n}(x_n - 1) + 4}{e^{x_n} + 1}$, $n = 0, 1, 2, 3, \dots$
- (ii) Using equation in b (i) and taking the approximate root in (a) as an initial approximation, obtain the root of the equation. Give your answer correct to three significant figures. (06 marks)
15. A certain company came up with a program of rearing goats. They visited a certain village to find out the modern ways of rearing goats and discovered that the number of goats owned by the residents were normally distributed 15% of the residents had less than 60 goats and 5 % of the residents had more than 90 goats.
- (a) Determine the mean and standard deviation of the number of goats. (08 marks)
 - (b) If the village had 300 residents rearing goats, find how many residents had more than 80 goats. (04 marks)
16. Forces, $(-2\mathbf{i} + 3\mathbf{j})\text{N}$, $(-\mathbf{i} + 2\mathbf{j})\text{N}$, $(4\mathbf{i} - 2\mathbf{j})\text{N}$ and $(-\mathbf{i} - 3\mathbf{j})\text{N}$ act at points A(-2, 3), B(3, 1), C(-1, -3) and D(3, 1) respectively.
- (a) Show that the system of forces forms a couple. (05 marks)
 - (b) If the force acting at points D (3, 1) is replaced by the force $(2\mathbf{i} + \mathbf{j})\text{N}$, determine the Cartesian equation of the line of action of the resultant force and where it crosses the x - axis. (07 marks)