

P425/2
APPLIED MATHEMATICS
Paper 2
July / August, 2024
3 hours



MASAKA DIOCESAN EXAMINATIONS BOARD
JOINT MOCK EXAMINATIONS 2024
Uganda Advanced Certificate of Education
APPLIED MATHEMATICS

Paper 2
3 hours

INSTRUCTIONS TO CANDIDATES

- Attempt **all** the questions in Section A and only **1** ve questions from section B.*
- All working must be shown clearly.*
- Extra numbers done will **not** marked.*
- Mathematical tables with a list of formulae and squared papers are provided.*
- Silent, non-programmable scientific calculators may be used.*
- In numerical work, take $g = 9.8\text{ms}^{-2}$*

SECTION A (40 marks)

Attempt all questions in this section.

1. (a) If events A and B are such that $P(A) = \frac{3}{4} P(B)$, $P(A/B) = \frac{7}{12}$ and $P(A \cup B) = \frac{7}{10}$
Find;
(a) $P(B)$, (03 marks)
(b) $P(B/A)$. (02 marks)
2. The position vectors of two particles P and Q at any time t are given as
 $r_p(t) = (2 + 4t^2)\mathbf{i} + (3t + 2)\mathbf{j}$ metres and $r_Q(t) = 6t\mathbf{i} + (4 + t)\mathbf{j}$ metres.
Show that the particles will overtake each other only once. (05 marks)
3. Given that the numbers $X = -2.40$, $Y = 1.7$ and $Z = 3.974$ are rounded off to the given number of decimal places.
(i) State the maximum possible errors in X , Y and Z . (01 mark)
(ii) Find the limits within which the exact value of $\frac{Z}{X+Y}$ lies. (04 marks)
Give your answer to 4 significant figures.
4. A random variable T is a uniformly distribution over the interval $0 \leq t \leq 2k$ where k is a positive constant.
i) Write down the p.d.f of T . (01 mark)
ii) Show that $E(T)$ and $E(T^2)$ are k and $\frac{4}{3} k^2$ respectively. (04 marks)
5. A particle describes S.H.M about O as the centre and amplitude a metres. Given that the periodic time of the motion is 4 seconds and the maximum speed of the particle is 2ms^{-1} .
Find the;
(a) value of a . (03 marks)
(b) speed of the particle when it is $\frac{3}{4}$ metres from O. (02 marks)
6. The Newton Raphson process for finding the root of the equation $f(x) = 0$ is given as
$$X_{n+1} = X_n - \frac{f(x_n)}{f_1(x_n)}, n = 0, 1, 2, \dots$$

Taking the initial approximation as x_0 , write down the algorithm based on this method for finding the root of $f(x) = 0$, to n decimal places. (05 marks)

7. Ten, 2023, candidates scored the following marks in two sets of mocks of Applied Mathematics.

Set 1	65	45	40	55	60	50	80	30	70	65
Set 2	60	60	55	60	50	40	85	50	70	80

- Calculate the rank correlation coefficient between the two sets of mocks. (04 marks)
 - Test for the significance at 1% level. (01 mark)
8. A non uniform rod AB of weight 20N, has its centre of gravity at G such that $AB = 1\text{m}$ and $2AG = 3GB$. The rod is freely hinged at A and rests in a horizontal position by means of a light inextensible string tied at end B and at a point C, vertically above A such that $AC = 0.7\text{m}$. Find the tension in the string. (05 marks)

SECTION B (60 marks)

Attempt only **five** questions from this section.

- Show that the equation $\pi \sin x - x = 0$ has a root between $\pi/2$ and π . Hence use linear interpolation method once to find the root to three significant figures. (05 marks)
 - Locate each of the roots of the equation $x^3 + 4 = 4x^2$. Hence estimate the largest root to two decimal places. (07 marks)
- A brick of mass 2kg is held on a rough inclined plane of inclination 60° to the horizontal. Given that the angle of friction between the plane and the brick is $\tan^{-1}(\mu)$ and less than 60° where μ is the coefficient of friction. Find in terms of μ the:

 - maximum horizontal force required to keep the brick in equilibrium. (06 marks)
 - minimum force required to drag the brick up the plane and show that it can be expressed as $P_{\min} = \frac{9.8}{\sqrt{1+\mu^2}} (\mu + \sqrt{3})$ (06 marks)
- A game consists of tossing four unbiased coins simultaneously. The total score is calculated by giving three points for each head and one point for each fail. The random variable X represents the total score.

 - Show that $p(X = 8) = 3/8$ (03 marks)
 - Copy and complete the table, given below, for the symmetrical probability distribution of X. (05 marks)

X	4	6	8	10	12
$p(x = x)$			$3/8$		

 - Calculate the variance of x. (04 marks)

12. (a) To a bus moving at 80kmh^{-1} in the direction $N 45^\circ W$, a plane appears to fly from the west at 30kmh^{-1} . Find the true speed and course of the plane. (05 marks)
- (b) From the top of a building, 45m high a stone is projected upwards with a speed of $V\text{ms}^{-1}$ and angle 30° to the horizontal. 2 seconds later, another stone is dropped from the same point. If the stones reach the ground at the same time, find the value of V . (07 marks)
13. The table below shows prices of commodities A, B, C and D for the years 2010 and 2011 and corresponding quantities

Commodity	2010		2011	
	Quantity in thousands	Price per unit in dollars	Quantity in thousands	Price per unit in dollars
A	34	100	112	120
B	96	110	88	100
C	10	50	112	65
D	11	80	10	85

Taking 2010 = "100"

Calculate for 2011 the;

- (a) Simple aggregate quantity index and comment on your answer. (04 marks)
- (b) Weighted aggregate price index number. (04 marks)
- (c) Value index number. (04 marks)
14. (a) Use the trapezium rule with 6 ordinates to estimate the area between the curve $y = xe^{-x}$ and the lines $x = 0$, $x = 1$. Give your answer to three decimal places. (06 marks)
- (b) Find the relative error in your estimation in (a) above and suggest how this error can be reduced. (06 marks)
15. During a certain delegates meeting, 40% of the delegates supported the idea of the science teachers' salary increment. If 450 delegates were interviewed by the NTV journalists about the idea, find the probability that;
- (a) Less than 150 delegates supported the salary increment. (06 marks)
- (b) Between 160 to 170 delegates supported the salary increment. (06 marks)
16. (a) A particle of mass 2kg moves with a velocity of $e^{3t}\mathbf{i} + 2e^{-2t}\mathbf{j} - \sin 2t\mathbf{k}$. Find the power developed after t seconds. (05 marks)
- (b) A car of mass 1200kg pulls a trailer of mass 300kg up a slope of 1 in 100 against resistance of 0.2N per kg. Given that the car moved at a consistent speed of 1.5ms^{-1} for 5 minutes. Calculate the;
- i) tension in the tow bar.
- ii) work done by the car engine during this time.

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