

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.  
Give your answer to 4 significant figures. (04 marks)
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  $2\text{ms}^{-1}$ .  
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.

9. (a) Show that the equation  $\pi \sin x - x = 0$  has a root between  $\pi/2$  and  $\pi$ . Hence use linear interpolation method once to find the root to three significant figures. (05 marks)
- (b) Locate each of the roots of the equation  $x^3 + 4 = 4x^2$ . Hence estimate the largest root to two decimal places. (07 marks)
10. A brick of mass 2kg is held on a rough inclined plane of inclination  $60^\circ$  to the horizontal. Given that the angle of friction between the plane and the brick is  $\tan^{-1}(\mu)$  and less than  $60^\circ$  where  $\mu$  is the coefficient of friction. Find in terms of  $\mu$  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)
11. 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)			$3/8$		

- (c) Calculate the variance of x. (04 marks)



12. (a) To a bus moving at  $80\text{kmh}^{-1}$  in the direction  $N 45^\circ W$ , a plane appears to fly from the west at  $30\text{kmh}^{-1}$ . 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  $30^\circ$  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

3. 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  $1.5\text{ms}^{-1}$  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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