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

NATIONAL EDUCATION RESEARCH & EXAMINATIONS BUREAU
UACE NEREB NATIONAL MOCKS 2024
APPLIED MATHEMATICS
PAPER 2
3 hours

INSTRUCTIONS TO CANDIDATES:

- *Answer **all** the **eight** questions in Section A and any **five** from Section **B**.*

- *Any additional question(s) answered will **not** be marked.*

- ***All** necessary working **mus**t be shown clearly.*

- *Graph paper is provided.*

- *Silent non-programmable **scientific calculators** and **mathematical tables** with a list of formulae may be used.*

- *In numerical work, take the acceleration due to gravity g, to be 9.8 ms^{-2}*

SECTION: A (40 MARKS)
*Answer **all** the questions in this section*

1. A coin is biased such that the probability of getting a head when $\frac{2}{7}$ tossed is .
   The coin is tossed six times. Determine the probability of obtaining;
   (i) exactly 5 heads. (02 marks)
   (ii) at least 4 tails. (03 marks)

2. To an observer on a train travelling at 3kmh⁻¹, a bird appears to fly due west at 4 kmh⁻¹. If the bird actually travels due North-West, find its speed. (05 marks)

3. The table below shows the variation of temperature with the height reached up a certain mountain.

Temperature(^{0}C)	8	5	-1
Height(m)	600	720	1100

   Use linear interpolation or extrapolation to estimate the:
   (i) temperature at a height of 800m. (02 marks)
   (ii) height of the mountain if the temperature at its peak is -7 ^{0}C. (03marks)

4. A discrete random variable X has a probability mass function given as

   $$f(x) = \begin{cases} kx & ; x = 1,2 \\ \frac{k}{3}(5-x) & ; x = 3,4 \\ k & ; x = 5,6 \end{cases}$$

   where k is a constant. Determine the;
   (a) value of the constant k (02 marks)
   (b) expectation $E(X)$. (03 marks)

5. A light elastic string has natural length 1.5m and modulus of elasticity 5N. One end of the string is attached to a fixed point O and a particle P of mass 0.1kg is attached to the other end of the string. P is released from rest at a point 2.4 m vertically below O. Calculate the kinetic energy of P at the instant the string first becomes slack. (05 marks)

6. Given the numbers A= 6.3, B= 3.12 and C= 5.1 are estimated with percentage errors 2, 3 and 1 respectively, determine the interval with in which the exact value of $\frac{B}{A-C}$ is expected to lie, correct to three decimal places. (05 marks)

7. The table below shows the expenditure of a certain family for months September and October in 2022.

ITEMS	EXPENDITURE (Shs.)		WEIGHT
	SEPTEMBER	OCTOBER	
Food	200,000	225,000	4
Accommodation	165,000	265,500	3
water	15,000	16,000	2
Miscellaneous	220,000	228,000	1

Calculate the cost of living index for the month of October based on September in 2022. (05 marks)

8.
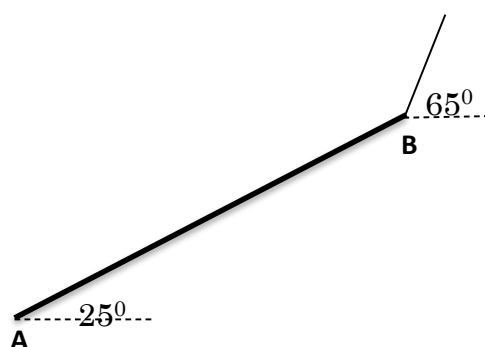
A uniform beam AB of length 30m and mass 200kg is held in limiting equilibrium by a light inextensible cable attached to B as shown in the diagram above. End A of the beam rests on a smooth horizontal surface, the angle between the beam and the horizontal surface is 25^0 and the cable makes an angle 65^0 with the horizontal. Find the:

    (i) tension in the cable. (02 marks)

    (ii) magnitude of the reaction at A (03 marks)

9. The following cumulative frequency table refers to ages of members of a certain youth club;

Age(years)	$14-$	$16-$	$18-$	$22-$	$24-$	$26-<28$
Cumulative frequency	5	15	26	48	60	70

(a)   Draw a cumulative frequency curve (Ogive)and use it to find the;
   (i)   median age
   (ii)   number of members who are 19 years and above.

(06 marks)

(b)   Calculate the;
   (i)   mean age
   (ii)   standard deviation of the club members

(06 marks)

10. A ball is thrown from a point A at a target T, which is on horizontal ground. The point A is 17.4m vertically above the point O on the ground. The ball is thrown from A with speed $25ms^{-1}$ at an angle of 30^0 below the horizontal and the distance OT is 21m.

The ball misses the target and hits the ground at the point B on the same horizontal line as O and T. Find the:
   (a)   time taken for the ball to travel from A to B.   (03 marks)
   (b)   distance TB.   (03 marks)
   (c)   speed of the ball as it passes a point C, which is vertically above T on the path of the ball.   (06 marks)

11. (a) Use the trapezium rule with 6 ordinates to estimate
$\int_1^2 \frac{2x}{x^2+1} dx$ correct to three decimal places.   (06 marks)

(b) Find the exact value of $\int_1^2 \frac{2x}{x^2+1} dx$, correct to three decimals places, hence find the error made in (a) above and state how the error can be reduced.

(06 marks)

12. (a) The masses of a particular variety of tomatoes is normally distributed with mean 105grams and standard deviation 16grams. Find the probability that a tomato chosen at random from the variety is:

        (i) less than 115grams.

        (ii) between 135grams and 145grams.

                                                          (06 marks)

    (c)   The time X, minutes taken by a town fire brigade to reach a fire scene from the instant they are called is approximately normally distributed the value of X was recorded on a random sample of 50 0ccassions on which the fire brigade was called and the results summarized below :

$\Sigma x = 286.5, \ \Sigma(x - x)^{-2} = 45.16$.

Determine the 98.5% confidence interval for the mean time taken by the town fire brigade team to reach a fire scene for all the occasions in town from the instant they are called.   (06 marks)

13. A particle of mass $2kg$ initially at rest at the point P whose position vector $(2\boldsymbol{i} - \boldsymbol{k})m$ is acted upon by a constant force of magnitude $12N$ acting in the direction $2\boldsymbol{i} - \boldsymbol{j} + 2\boldsymbol{k}$.

(a) Find the acceleration acting of the particle.   (04 marks)

(b) Determine the displacement of the particle from P after 2 seconds**.**

                                                    (05 marks)

(c) Work done by the force on the particle after 2 seconds**.**

                                                      (03 marks)

14. (a) Show that the formula based on Newton Raphson method for estimating the root of the equation $e^x + x - 4 = 0$ is given by;

$$x_{n+1} = \frac{(x_n - 1)e^{x_n + 4}}{e^{x_n} + 1} ; n = 0, 1, 2..$$ *(04 marks)*

    (b) Construct a flow chat that:

          Reads the initial approximation, x_0

          Computes and prints the root of the equation

          $e^x + x - 4 = 0$ correct to 3 decimal places.   (05 marks)

    (c) Using $x_0 = 1.1,$ perform a dry run for the flow chart.

                                                      (03 marks)

15.(a) Events A and B are such that $P(A/B) = \frac{2}{3}$, $P(A/B^1) = \frac{2}{3}$ and $P(B) = \frac{4}{7}$

Find the;

    (i) *P(A)*   (03 marks)

    (ii) $P\left(B/A^1\right)$ (02 marks)

(b) Kelly and Jolly play a game repeatedly. The probability that Kelly wins any game is 0.3. Each game is won by either Kelly or Jolly. They stop playing when one of them has won two games and becomes the champion.

    (i)   Find the probability that Jolly becomes the champion after playing exactly 2 games.   (02 marks)

    (ii)   Find the probability that jolly becomes the champion.

                                                  (03 marks)

    (iii)   Given that Kelly becomes the champion, find the probability that he won the second game.   (02 marks)

16.(a) Three particles of mass 2kg, 3kg and *m*kg are situated at points (-1, 4), (1, -1) and (3,1) respectively. If the centre of mass of the system lies at a point (1, λ), find the values of m and λ.   (04 marks)

(b) A thin uniform wire is bent to form a frame in the shape of the trapezium ABCD, where AB = AD = 4cm, CD = 5cm, and AB is perpendicular to BC and AD, as shown in the figure below.
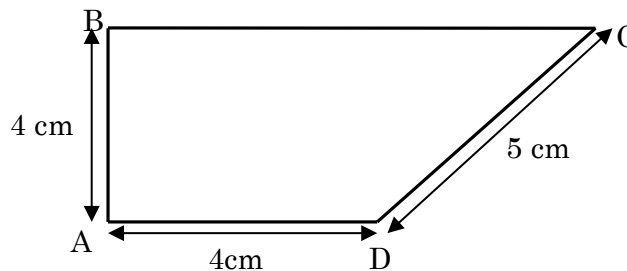
Find the distances of the centre of mass of the frame from AB and AD.   (08 marks)

END