

**P425/2**  
**APPLIED MATHEMATICS**  
**Paper 2**  
**Sept. 2023**  
**3 HOURS**

***UGANDA ADVANCED CERTIFICATE OF EDUCATION***

**APPLIED MATHEMATICS**  
**(PRINCIPAL SUBJECT) SET 1**

**Paper 2**  
**TIME: 3 HOURS**

**INSTRUCTIONS TO CANDIDATES:**

*Answer **all** the **Eight** questions in Section **A** and **Five** questions from Section **B**.*

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

***All** necessary working **must** be clearly shown.*

*Begin each answer on a fresh sheet of paper.*

*Graph paper is provided.*

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

*In numerical work, take  $g$  to be  $9.8 \text{ ms}^{-2}$ .*

### SECTION A: (40 MARKS)

Answer **all** the questions in this section

- Two events A and B are such that  $P(A) = 0.6$ ,  $P(A \cap B) = 0.4$  and  $P(\bar{A} \cap \bar{B}) = 0.2$ , find;  
(i)  $P(\bar{B})$  (ii)  $P(A \text{ or } B \text{ but not both } A \text{ and } B)$
- P, Q and R are points on a straight road such that  $PQ = 2\text{km}$  and  $QR = 2\text{km}$ . A cyclist moving with uniform acceleration passes P and then notices that it takes him 100s and 150s to travel between (P and Q) and (Q and R) respectively. Find  
(i) uniform acceleration (ii) initial velocity.
- The data below represents the length of leaves in cm, 4.4, 6.2, 9.4, 12.6, 10.0, 8.8, 3.8 and 13.6. Find the;  
(i) Mean (ii) Standard deviation
- Show that the equation  $f(x) = x^3 - 3x - 12$ , has a root between  $x = 2$  and  $x = 3$ . Hence using linear interpolation once, estimate the root to two decimal places.
- Forces of magnitude 5N,  $2\sqrt{3}\text{N}$ , 16N and 4N act on a body in the direction of  $0^\circ$ ,  $60^\circ$ ,  $120^\circ$  and  $270^\circ$  respectively. Determine the;  
(a) Resultant force and magnitude (b) Direction of the resultant force
- The table below shows the expenditure of a certain family for the January and March 2022

Items	Expenditure (Shs)		Weight
	January	March	
Food	300,000	325,000	5
Accommodation	260,000	362,000	3
Electricity	150,000	160,000	1
Miscellaneous	620,000	725,000	2

- Calculate the weighted expenditure index for the month of March based on January 2022
  - If the expenditure in January was 1,350,000/=-, use the index above to estimate the expenditure in March.
- A particle of weight 6N is placed on a rough plane inclined at  $45^\circ$  to the horizontal, if the coefficient of friction between the particle and the plane is  $\frac{1}{2}$ . Find the magnitude of the least horizontal force required to maintain the particle in equilibrium

8. The table below is an extract from the table of  $\cos x$ .

	0'	10'	20'	30'	40'	50'
80°	0.1736	0.1708	0.1679	0.1650	0.1622	0.1593

Use linear interpolation to determine

(i)  $\cos 80^\circ 36'$

(ii)  $\cos^{-1}(0.1685)$ .

### SECTION B: (60 MARKS)

Answer any **five** questions in this section. All questions carry **equal** marks

9. The numbers  $a$  and  $b$  have errors  $e_1$  and  $e_2$  respectively.

(a) Show that the maximum relative error made in the approximation of  $\frac{a}{\sqrt{b}}$  is

$$\left| \frac{e_1}{a} \right| + \frac{1}{2} \left| \frac{e_2}{b} \right|$$

(b) Given that  $a = 42.3$ ,  $b = 27.31$  and  $c = 12.333$ , are rounded off to the given decimal places, find the maximum value and minimum value hence percentage error in the expression  $\frac{a}{b+c}$

10. Two particles P and Q move in a straight line. Q being 18m in front of P, Q starts from rest with acceleration of  $3\text{ms}^{-2}$  and P starts in pursuit with a velocity of  $10\text{ms}^{-1}$  and an acceleration of  $2\text{ms}^{-2}$ . Prove that;

(i) P will overtake and pass Q after an interval of 2 seconds

(ii) Q will in turn over take P after a further interval of 16 seconds

11. (a) A bag contains 5 blue and 4 red balls, 3 balls are drawn from the bag one at a time without replacement. Determine the probability

(i) All are blue

(ii) 2 are red and 1 is blue

(b) Daniel's probability of passing Physics, Economics and Mathematics are 0.6, 0.75 and 0.8 respectively, find the probability that he;

(i) Passes at least two subjects

(ii) Failed economics given that he passed at least two subjects

12. The data below represents the body mass ( $x$ ) and the heart mass ( $y$ ) of fourteen 10 month old male mice

Body mass ( $x$ )	27	30	37	38	32	36	32	32	38	42	36	44	33	38
Heart mass ( $y$ )	118	136	156	150	140	155	157	114	144	159	149	170	131	160

(a) Construct a scatter diagram, draw the line of best fit and comment on it

(b) Estimate the heart mass ( $y$ ), if the body mass ( $x$ ) is 35

(c) Calculate the rank correlation and comment at 1% level of significance

13. (a) Use Newton Raphson formulae, derive the simplest iterative formula to determine the cube root of a number A is given by;

$$x_{n+1} = \frac{1}{3} \left( 2x_n + \frac{A}{x_n^2} \right); n = 0, 1, 2 \dots$$

- (b) Using  $x_0 = 4$  and  $A = 68$  using Newton Raphson method, find the root and Correct it to 3 decimal places

14. A particle of mass  $2m$  rests on a rough plane inclined to the horizontal at an angle of  $\tan^{-1}(3\mu)$  where  $\mu$  is the coefficient of friction between the particle and the plane.

The particle is acted upon by a force of  $P$  Newton's.

- (a) Given that the force acts along the line of greatest slope and that the particle is on the point of slipping up, show that the maximum force possible to maintain the

particle in equilibrium is  $P_{max} = \frac{8\mu mg}{\sqrt{1+9\mu^2}}$

- (b) Given that the force acts horizontally in a vertical plane through a line of greatest slope and that the particle is on the point of sliding down the plane, show that the

minimum force required to maintain the particle in equilibrium is  $P_{min} = \frac{4\mu mg}{1+3\mu^2}$

15. A random variable  $X$  takes integer values only and has probability density function given as;

$$P(X=x) = \begin{cases} kx^2; & x = 1, 2, 3 \\ k(7-x)^2; & x = 4, 5, 6 \\ 0; & \text{otherwise} \end{cases}$$

Where  $k$  is a constant, determine the;

(i) Value of  $k$

(ii)  $E(X)$  and  $\text{Var}(X)$

(iii) Median and mode

(iv)  $P\left(x \leq 3 / x \leq 5\right)$

16. ABCDEF is a regular hexagon of side  $4m$ , Forces of magnitude  $2N$ ,  $6N$ ,  $5N$ ,  $8N$ , and  $3N$  act along the sides  $AB$ ,  $BC$ ,  $CD$ ,  $ED$  and  $EF$  respectively. Taking  $AB$  and  $AE$  as the reference positive  $x$  and  $y$  axes respectively, determine the;

(a) Magnitude of the resultant force and its direction

(b) Line of action of resultant force by taking moments about  $A$  and point where it cuts  $AB$