

2920/106
COMPUTATIONAL MATHEMATICS
July 2021
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL
DIPLOMA IN INFORMATION COMMUNICATION TECHNOLOGY

MODULE 1

COMPUTATIONAL MATHEMATICS

3 hours

INSTRUCTIONS TO CANDIDATES

*This paper consists of EIGHT questions.
Answer any FIVE questions in the answer booklet provided.
Candidates should answer the questions in English.*

This paper consists of 5 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

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Turn over

1. (a) Convert each of the following numbers to the equivalent number system indicated showing all your workings:

- (i) 764_8 to decimal
- (ii) $E5_{16}$ to octal
- (iii) 679_{10} to binary
- (iv) 111010_2 to hexadecimal

764_8 8×164
 $4 \times 8^0 = 4$
 $6 \times 8^1 = 48$
 $7 \times 8^2 = 448$

 500_{10}

(8 marks)

(b) Distinguish between a *weighted binary code* and *un-weighted binary code* giving an example in each case. (5 marks)

(c) Peter and Winnie play a game and their chances of winning are in the ratio 3:5. Given that they played 6 games, determine the probability that:

- (i) Peter wins all the games; (2 marks)
- (ii) Peter wins in 2 or 3 games; (3 marks)
- (iii) Winnie wins at most in 5 games. (2 marks)

$3:5 \Rightarrow 3 \times 5 = 15$
 $3/15 = 1/5$
 $5/15 = 1/3$

$0-10000$
 $1-00001$
 $2-00010$
 $3-00011$
 $4-00100$
 $5-00101$
 $6-00110$
 $7-00111$
 $8-01000$
 $9-01001$
 $10-01010$
 $11-01011$
 $12-01100$
 $13-01101$
 $14-01110$
 $15-01111$

(a) The following statements describe properties about finite sets.

- (i) $P = \{3,4,5\} = \{5,3,4\} = \{4,3,5,4,3\}$; false
- (ii) Given $Q = \{6,7,8\}$ and $R = \{7,8,9,6,5\}$ $Q \not\subseteq R$; false
- (iii) If $A = \{21,22,23, \dots, 30\}$ then $|A| = 20$; false
- (iv) If $A = \{1,2\}$ then $|P\{1,2\}| = 3$; false

State whether each of the statements are true or false. (4 marks)

(b) Using the event "tossing coin", explain each of the following events as applied in probability.

- (i) equally likely; similar events
- (ii) complementary; events that are shared (6 marks)

(c) Tom, Mary and Peter went to a shop to purchase supplies for making decorations. Tom spent Kshs 2,440 when he purchased 3 sheets of craft paper, 4 boxes of markers and 5 glue sticks. Mary spent Kshs 3,040 when she bought 6 sheets of craft paper, 5 boxes of markers and 2 glue sticks. Peter spent Kshs 1,340 when he bought 3 sheets of craft paper, 2 boxes of markers and 1 glue stick.

- (i) Write the narrative as a system of equations. (4 marks)
- (ii) Determine the cost of each item. (6 marks)

Tom	Mary	Peter
2440	3040	1340

 $3x + 4y + 5z = 2440$
 $6x + 5y + 2z = 3040$
 $3x + 2y + z = 1340$

Explain each of the following levels for variable measurements as applied in statistical data.

- (i) Nominal level;
- (ii) Ordinal level;
- (iii) Interval. (6 marks)

$(\begin{matrix} x \\ y \\ z \end{matrix}) \begin{pmatrix} 3 & 4 & 5 \\ 6 & 5 & 2 \\ 3 & 2 & 1 \end{pmatrix} \begin{matrix} = 2440 \\ = 3040 \\ = 1340 \end{matrix}$

$3x + 4y + 5z = 2440$
 $6x + 5y + 2z = 3040$
 $3x + 2y + z = 1340$

$3 \times 2440 = 7320$
 $3 \times 3040 = 9120$
 $3 \times 1340 = 4020$

$2 \overline{) 500}$
 $2 \overline{) 250}$
 $2 \overline{) 125}$
 $2 \overline{) 62}$
 $2 \overline{) 31}$
 $2 \overline{) 15}$
 $2 \overline{) 7}$
 $2 \overline{) 3}$
 $2 \overline{) 1}$
 $2 \overline{) 0}$

1111101100
 10000
 10001
 20010
 30011
 40100
 50101
 60110
 70111
 8000
 9001
 1000
 1100
 1201
 1300
 1400
 1501
 1600
 1701
 1800
 1901
 2000
 2101
 2200
 2301
 2400
 2501
 2600
 2701
 2800
 2901
 3000

- (b) Rama, Shem and Mogan purchased cookies of different brands P, Q and R. Rama purchased 10 packets of P, 7 packets of Q and 3 packets of R. Shem purchased 4 packets of P, 8 packets of Q and 10 packets of R. Mogan purchased 4 packets of P, 7 packets of Q and 8 packets of R. The cost of each brand is Kshs 40, 50 and 60 respectively.
- (i) Represent the information in matrices notation (4 marks)
- (ii) Use the matrix method to determine the amount of money spent by each person. (2 marks)
- (c) Use the cofactor method to determine the inverse of matrix $D = \begin{bmatrix} 3 & 1 & 6 \\ 2 & 0 & 4 \\ 5 & 7 & 2 \end{bmatrix}$. (8 marks)

4. (a) (i) Outline three features of *symbolic model*. (3 marks)
- (ii) A certain shop has all their commodities on sale with a 15% discount offer.
- (I) Formulate a mathematical model that could be used to determine the sale price of each commodity in the shop. (3 marks)
- (II) Using the model formulated in (I), determine the sale price of a commodity whose original price is Ksh 500. (2 marks)

(b) The following statements describes various operations:

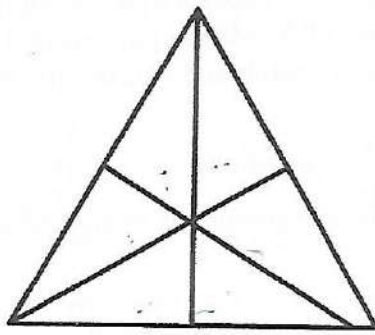
- (i) Picking a team of 3 student leaders' from a group of 10 students;
- (ii) Picking a chairman, secretary and treasurer from a group of 10 students;
- (iii) Choosing 3 desserts from a menu of 10;
- (iv) Listing your 3 favourite desserts, in order, from a menu of 10;

State whether each of the statement requires a *permutation* or a *combination* operation. (4 marks)

- (c) A 4-digit PIN number is to be formed using the digits 0,3, 5, 7, 8 and 9 such that the PIN is divisible by 10 and there is no repeating digit. Determine the number of PINs that would be formed. (4 marks)
- (d) Distinguish between *absolute error* and *relative error* as used in measurement. (4 marks)

- 5 (a) (i) State the meaning of the following terms as used in logical mathematical statements:
- (I) Tautology;
- (II) Contradiction. (2 marks)
- (ii) Use a truth table to determine whether each of the following is either a tautology or contradiction:
- (I) $A \wedge (\neg (A \vee B))$;
- (II) $P \vee (P \leftrightarrow Q) \vee Q$. (6 marks)

- (b) A pupil in nursery school was asked to paint each section of the following shape using 8 crayons of different colours.



6
1/8, 2/8, 3/8, 4/8, 5/8

Determine the total number of ways of painting the shape. (4 marks)

- (c) With the aid of a truth table, describe each of the following gates as applied in electronics.

- (i) AND - series of logic gates with 2 or more switches
(ii) OR - parallel logic gates with 2 or more switches
(iii) NOT (8 marks)

6. (a) Outline three characteristics of each of the following types of skewness:

- (i) positive skewness;
(ii) negative skewness. (6 marks)

- (b) Explain three differences between absolute measures and relative measures as used in statistics. (6 marks)

- (c) Use truth tables to prove the following digital algebraic equation:

$$\overline{AB} = \overline{A} + \overline{B} \quad (4 \text{ marks})$$

- (d) Use the graphical method to solve the quadratic equation:

$$3x^2 + 5x - 2 = 0$$

$$3x^2 + 5x - 2 = 0$$

$$3x(x + \frac{5}{3}) - 2(x - 2)$$

(4 marks)

7. (a) (i) Outline two limitations of using charts to represent statistical data. (2 marks)

- (ii) Table 1 shows the frequency distribution of packets of milk produced by a farm for a period of six months. Use it to answer the question that follows.

x F
Jan 10490
Feb 12325
March 10201
April 7496
May 4816
Jun 3678

Month	Jan	Feb	march	April	May	June
Frequency	10490	12325	10201	7496	4816	3678

Table 1

Represent the information using a histogram (4 marks)

- (b) A polynomial function is given by $f(x) = x^2 - 4x - 7 = 0$. Using the Newton Raphson iterative method, determine the root of the equation rounded off to 4 decimal places. Take the initial root $x_0 = 5$. (6 marks)

Handwritten work for Newton-Raphson method:

$$f(x) = x^2 - 4x - 7 = 0$$

$$f'(x) = 2x - 4$$

$$x_0 = 5$$

$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)} = 5 - \frac{5^2 - 4(5) - 7}{2(5) - 4} = 5 - \frac{25 - 20 - 7}{10 - 4} = 5 - \frac{-2}{6} = 5 + \frac{1}{3} \approx 5.3333$$

$$x_2 = x_1 - \frac{f(x_1)}{f'(x_1)} = 5.3333 - \frac{(5.3333)^2 - 4(5.3333) - 7}{2(5.3333) - 4} = 5.3333 - \frac{28.4444 - 21.3332 - 7}{10.6666 - 4} = 5.3333 - \frac{0.1112}{6.6666} \approx 5.3333 - 0.0167 = 5.3166$$

$$x_3 = x_2 - \frac{f(x_2)}{f'(x_2)} = 5.3166 - \frac{(5.3166)^2 - 4(5.3166) - 7}{2(5.3166) - 4} = 5.3166 - \frac{28.2666 - 21.2664 - 7}{10.6332 - 4} = 5.3166 - \frac{0.0002}{6.6332} \approx 5.3166 - 0.00003 = 5.3166$$

Graphical representation of the function $f(x) = x^2 - 4x - 7$ showing the root between 5 and 6.

- (c) The radius of a sphere was measured and found to be 20 cm with a possible error in measurement of 0.01 cm.
- (i) Determine the maximum error in the computation of volume using this value of the radius. (4 marks)
- (ii) Determine the relative error in each of the following measures:
- (I) Radius;
- (II) Volume. (4 marks)

8. (a) State the meaning of each of the following terms as used in probability:
- (i) random experiment;
- (ii) sample space;
- (iii) outcome;
- (iv) sample point. (4 marks)
- (b) Distinguish between *discrete random variable* and *continuous random variable* as used in probability. (4 marks)
- (c) Distinguish between *odd* and *even* parity as applied in digital communications. (4 marks)
- (d) Use the algebraic iterative formula $x_{n+1} = \sqrt[3]{20 - 5x_n}$ to determine the solution of the equation $x^3 + 5x = 20$ given the initial value $X_0 = 2$. Give your answer to 3 decimal places. (8 marks)

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