2920/106
COMPUTATIONAL MATHEMATICS
March/April 2023
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN INFORMATION COMMUNICATION TECHNOLOGY

MODULE I

COMPUTATIONAL MATHEMATICS

3 hours

INSTRUCTIONS TO CANDIDATES

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

This paper consists of 6 printed pages.
Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

Turn over

1. (a) Perform each of the following estimation on the number 10.6783:

(i) Round off to:

(I) 2 decimal places;

(II) whole number; (2 marks)

(ii) Truncate to:

(I) 2 decimal places;

(II) whole number; (2 marks)

(b) With the aid of an illustration in each case, describe each of the following mathematical models:

(i) histogram;

(ii) frequency polygon. (6 marks)

(c) Draw a graph for the function $f(x) = x^2 - 2$, where $-3 \leq x \leq 3$ on the grid provided at the back of the answer booklet. (5 marks)

(d) Use the graphical method to solve the following simultaneous equations for $0 \leq x \leq 6$:

$3x + 5y = 14$

$5x + 2y = 17$ (5 marks)

2. (a) State the type of matrix P and matrix Q, giving a reason for your answer: (4 marks)

$$\mathbf{P} = \begin{pmatrix} 4 & 0 & 0 \\ 0 & 6 & 0 \\ 0 & 0 & 1 \end{pmatrix} \qquad \mathbf{Q} = \begin{pmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{pmatrix}$$

(b) Using two's complement, compute the binary subtraction of 54_{10} - 15_{10}. (4 marks)

(c) Convert each of the following number systems to its respective equivalent:

(i) 475_8 to decimal;

(ii) 11111001_2 to hexadecimal;

(iii) 1110011_2 to octal (6 marks)

(d) Table 1 shows the frequency distribution of marks obtained by 710 candidates who sat for Computational Mathematics examination. Use it to answer the questions that follow.

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Frequency	10	35	60	120	150	110	95	75	35	20

Table 1

Estimate by calculation, each of the following measures about the marks:

(i) mean;

(ii) median;

(iii) standard deviation. (6 marks)

3. (a) (i) Outline **two** properties of *arithmetic mean* as a measure of central tendency. (2 marks)

(ii) Distinguish between *leptokurtosis* and *platikurtorsis* as used in statistics. (4 marks)

(b) Describe each of the following character encoding method as used in computers:

(i) ASCII;

(ii) EBCDIC. (4 marks)

(c) A college has a swimming team that consists of 150 members. 75 of the members are advanced swimmers, 45 are intermediate swimmers and the rest are beginners. Of those who practice at least four times a week; 45 are advanced swimmers, 35 intermediate and 10 are beginners. A member is randomly chosen from the team, determine the probability that the member is a:

(i) beginner;

(ii) practices 4 times a week;

(iii) an advanced swimmer and practices at least 4 times a week. (4 marks)

(d) Using elimination method, determine the value of the matrices X and Y in the following simultaneous equations:

$$2X + 3Y = \begin{pmatrix} 2 & 3 \\ 4 & 0 \end{pmatrix}$$

$$3X + 2Y = \begin{pmatrix} 2 & -2 \\ -1 & 5 \end{pmatrix}$$

(6 marks)

4. (a) (i) Using binomial theory, expand the expression $(3 + 2y)^5$, simplifying the terms. (4 marks)

(ii) Hence, determine the binomial expansion of $(3+2y)^5 + (3-2y)^5$. (2 marks)

(b) Distinguish between *linear interpolation* and *linear extrapolation* as used in numerical analysis. (4 marks)

(c) The radius of a circular plate is measured as 12.65 cm instead of the actual length 12.5 cm. Determine each of the following in computing the area of the circular plate:

(i) absolute error; (4 marks)

(ii) percentage error. (2 marks)

(d) Given matrix $\boldsymbol{S} = \begin{bmatrix} 5 & -7 \\ 3 & 6 \end{bmatrix}$, use the co-factor method to determine S^{-1}. (4 marks)

5. (a) Describe each of the following types of binary codes:

(i) weighted;

(ii) non-weighted. (4 marks)

(b) Solve each of the following inequalities:

(i) $4(x-2) > 3(9-x)$

(ii) $-12 \leq 5x-8 \leq 12$ (4 marks)

(c) In a class of 200 students, 120 of them study humanities, 50 study engineering and 30 study both humanities and engineering.

(i) Present this information using a Venn diagram. (2 marks)

(ii) Determine the number of students who study:

(I) humanities but not engineering;

(II) engineering but not humanities;

(III) humanities or engineering. (6 marks)

(d) A company installed a smoke detector system with two devices P and Q. If smoke is present, the probability that device P will detect it is 0.95, the probability that device Q will detect it is 0.98 and the probability that both devices will simultaneously detect it is 0.94. If smoke is present, determine the probability that the smoke will:

(i) be detected by device P or Q. (2 marks)

(ii) not be detected. (2 marks)

6. (a) State **two** differences between *quantitative data* and *qualitative data* as used in statistics. (4 marks)

(b) A researcher conducted a survey on the number of languages college graduates from three different departments could speak and found out that in:

- engineering department, 12 spoke one language while 1 spoke two languages.
- education department, 4 spoke one language while 3 spoke two languages.
- Medicine department, 6 spoke one language and 2 spoke two languages.

(i) Construct a contingency table to represent this information. (2 marks)

(ii) A graduate is selected at random, determine the probability that the graduate:

(I) is from medicine department and speaks two languages; (2 marks)

(II) is from medicine department or speaks two languages; (4 marks)

(c) Table 2 shows the amount of fertilizer in kilograms applied to five different plots of equal size and the respective yields in tonnes for the period. Use it to answer the questions that follow.

Amount of fertiliser (kg)	1891	1901	1911	1921	1931
Yield in tonnes	46	66	81	93	101

Table 2

(i) Construct *Newton's backward difference* table. (4 marks)

(ii) Determine the Newton's interpolating polynomial and estimate the yields from a plot where 1925 kilograms of fertilizer was applied. (4 marks)

7. (a) (i) State the meaning of the term *random variable* as used in statistics. (1 mark)

(ii) Outline **two** examples of random variables used in statistics. (2 marks)

(b) State whether each of the following conditions describes an *even parity scheme* or *odd parity scheme* error detection in binary codes if the data is represented by:

(i) even number of 1's, the parity bit is 0;

(ii) odd number of 1's, the parity bit is 0;

(iii) odd number of 1's, the parity bit is 1;

(iv) even number of 1's, the parity bit is 1. (4 marks)

(c) Figure 1 shows a system that consists of logic gates, Use it to answer the questions that follow.

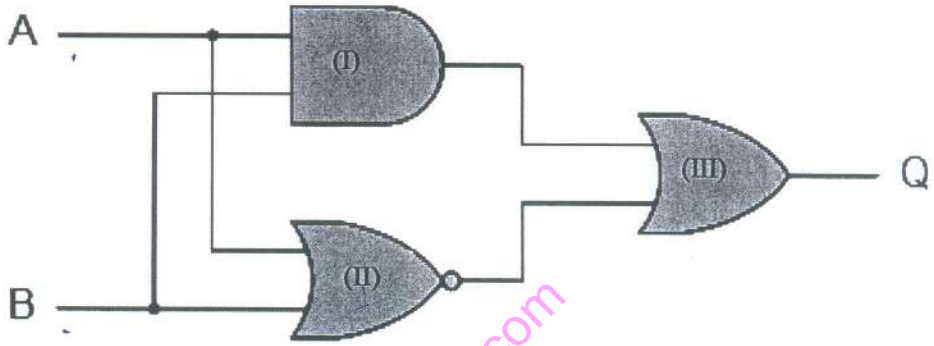

Figure 1

(i) Identify the logic gates labelled (I), (II) and (III) (3 marks)

(ii) Determine the Boolean algebra for the system. (3 marks)

(d) A group of volunteers consists of 18 people from different cities in Kenya. Among the volunteers, 5 are from Nairobi, 6 are from Nakuru and 7 are from Kisumu. A committee consisting of 7 members is chosen at random. Determine the number of ways the committee can be chosen:

(i) without restrictions (1 mark)

(ii) to consist of 2 members from Nairobi, 2 from Nakuru and 3 from Kisumu. (3 marks)

(iii) to have exactly 5 members from Kisumu. (3 marks)

8. (a) (i) State **eight** sources of primary data in statistics. (4 marks)

(ii) Explain the term *census* as used in data collection. (2 marks)

(b) Explain the **two** categories of statistical units that may be used during data collection. (4 marks)

(c) (i) With the aid of a diagram, draw a 2- input *OR* gate. (3 marks)

(ii) Derive the truth table for the gate in (i). (2 marks)

(d) A bulb manufacturing company sells each bulb at KSh 45. During production of the bulbs, the company incurs KSh 25 per bulb and a fixed cost of KSh 1600. Determine whether the company makes a profit or a loss by selling each of the following quantities of bulbs:

(i) 75;

(ii) 150. (5 marks)

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