2920/106
COMPUTATIONAL MATHEMATICS
July 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN INFORMATION AND COMMUNICATION TECHNOLOGY

MODULE I

COMPUTATIONAL MATHEMATICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
  Scientific calculator;
  Statistical tables.
*This paper consists of **EIGHT** questions.*
*Answer any **FIVE** of the **EIGHT** questions in the answer booklet provided.*
Candidate should answer the questions in English.

This paper consists 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.

1. (a) The following are examples of measurement used for statistical data:

    • gender of student;
    • actual marks scored by students in an examination;
    • time of the day lessons commence on the timetable;
    • rank attained by students in an examination;
    • age in years of patients who attended a clinic;
    • seat number in a passenger bus;
    • overall student academic performance as good, average or poor;
    • latitude of a point on the earth surface in degrees north or south.

    Classify them into the following measurement scales: nominal, ordinal, interval and ratio.
    (4 marks)

    (b) Determine the equation of a straight line which passes through the two points (4, 9) and (8, 3), and hence determine the equation of another straight line which is perpendicular to the first line and passes through the point (6, 8). $M_1 M_2 = -1$ $M_2 = -\frac{1}{M_2}$ (6 marks)

    (c) John has a rectangular plot of land whose area is 1600 square metres and whose perimeter is 200 metres. He has another rectangular plot of land whose length is twice as long as its width and has an area measuring 7200 square metres. He intends to fence the two plots using poles which are 4 meters apart.

    (i) Determine the dimensions of each plot;

    (ii) Determine the number of poles John needs to fence the two plots assuming the plots are separate.
    (6 marks)

    (d) A bag contains 6 red, 4 white and 8 blue balls. The balls are identical in all aspects except colour. Three balls are picked at random one at a time with replacement. Determine the probability that of the three balls picked, two are blue and one white in colour.
    (4 marks)

2. (a) Explain **two** circumstances in which the *median* would be more appropriate than the *mean* as a measure of central tendency.
    (4 marks)

    (b) Table 1 shows the age distribution of 800 employees working for a certain multinational organisation. Use it to answer the questions that follow.

Age group	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64
No. of persons	25	75	140	130	145	120	90	55	20

    Table 1

    (i) Estimate by calculation the following measures about the age of the employees:

    (I) the median; $= L + \left(\frac{d_1}{d_1 + d_2}\right) c$
    (II) the inter-quartile range;
    (III) the standard deviation. $\sqrt{\frac{f(x - \bar{x})}{\Sigma f}}$
    (10 marks)

(ii) The oldest 32% of the employees are allowed to retire voluntarily. Determine the minimum age for an employee to be allowed to retire voluntarily. (3 marks)

(iii) Suppose the minimum age for voluntarily retirement is set at 47 years, determine the proportion of employees who would qualify to retire voluntarily. (3 marks)

3. (a) Explain each of the following character coding systems as used in computers.

(i) *Extended* BCD;

(ii) ASCII;

(iii) EBCDIC. (6 marks)

(b) Convert each of the following number systems to their respective equivalents:

(i) 647258 to hexadecimal;

(ii) 64728 to binary;

(iii) 84610 to binary;

(iv) 11100100112 to decimal. (8 marks)

(c) A mobile phone network uses 10 digits to assign phone numbers to its subscribers. However, the first two digits must be a 0 (zero) and a 7 in that order, the third digit must be one of the following: 0, 1, 2, 4 or 8, the fourth digit can be any, the fifth digit must not be a 0 (zero). Each of the last remaining 5 digits can be any digit, but the 5 digits must not all be the same digit as such numbers are reserved for special customers. Determine the maximum number of subscribers which can be accommodated by this system excluding the reserved numbers. (6 marks)

4. (a) Explain each of the following terms as used in computer data representation:

(i) a number;

(ii) a character code. (4 marks)

(b) State the general binomial theorem where n is a positive integer. Hence use it to expand the binomial expression below in ascending powers of x.

$$(3x + 2y)^5$$ (6 marks)

(c) Given the polynomial function $f(x) = 2x^3 - 5x^2 + 6x - 7$, use the Newton-Raphson iterative method to find the root of the equation, rounded off to 6 decimal places. Take the initial root $x_0 = 1.5$. (10 marks)

5. (a) Explain the term *conditional probability* as used in probability theory. (2 marks)

(b) Define each of the following terms as used in computer coding systems:

(i) even parity;

(ii) odd parity. (4 marks)

(c) Outline **four** characteristics of a *well designed questionnaire* as a tool in the collection of statistical data. (4 marks)

(d) Given two matrices **A** and **B** below:

$$A = \begin{bmatrix} 2 & 3 \\ 1 & 4 \\ 5 & 2 \end{bmatrix}, \quad B = \begin{bmatrix} 5 & 3 & 8 \\ 1 & 6 & 2 \end{bmatrix}$$

Determine each of the following:

(i)   the transpose of **A**;

(ii) **AB**;

(iii) $B^T + A$;

(iv) $(BA)^{-1}$ (10 marks)

6. (a) Outline **four** advantages of representing data using charts. (2 marks)

(b) The data in Table 2 represents the revenue in millions of Kenya shillings received by a certain university for four consecutive years. Use it to answer the questions that follow.

	Year 1	Year 2	Year 3	Year 4
Semester 1	35	42	55	48
Semester 2	40	45	60	57
Semester 3	25	28	35	30

Table 2

Present the data in Table 2 using each of the following charts:

(i)   Simple bar chart;

(ii) Grouped bar chart;

(iii) Component bar chart. (8 marks)

(c) A box contains 8 green apples and 4 red apples that are identical in all aspects except colour. A customer picked 2 apples at random from the box one at a time.

(i)   Suppose the 2 apples are picked with replacement, present this information using a probability tree diagram. Hence, determine the probability that all the apples picked are of the same colour. (5 marks)

(ii) Suppose the 2 apples are picked without replacement, present this information using a probability tree diagram. Hence, determine the probability that all the apples picked are of different colours. (5 marks)

7. (a) Define the term *logic gate* as used in digital electronic systems. (2 marks)

(b) Explain the following *logic gates*, illustrating each using a truth table with two inputs:

(i) OR gate;

(ii) AND gate;

(iii) XOR gate. (9 marks)

(c) Identify a set of logic gates that would constitute a circuit that receives two input signals **A** and **B**, performs an addition operation and outputs a **Sum** and a **Carry** as illustrated by the truth table below.

Input		Output	
A	**B**	**Sum**	**Carry**
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

(3 marks)

(d) There was an outbreak of a mysterious disease, which has known symptoms in a certain county. However, doctors realised that not all people who have the disease display the symptom and not all those who display the symptom have the disease. After conducting a medical survey among a random sample of 120 patients in the area, the findings were as follows:

- 48 patients who displayed the symptom had the disease;

- 32 patients who displayed the symptom did not have the disease;

- 16 patients who had the disease did not display the symptom;

- 24 patients who did not have the disease, did not display the symptom;

(i) Present this information using a contingency table. (2 marks)

(ii) A patient who has the disease is selected at random from the area, determine the probability that he displays the symptom. (2 marks)

(iii) A patient who displays the symptom is selected at random from the area, determine the probability that he has the disease. (2 marks)

8. (a) Explain the term *derivative of a function* as used in Mathematics. (2 marks)

(b) Determine the turning point(s) for each of the following polynomial functions, and specify the type of the turning point:

(i) $y = 9x - 24x^2 - 40$;

(ii) $y = x^3 - 5x^2 - 15x + 80$. (6 marks)

(c)　　Given matrix **A**,

$$\mathbf{A} = \begin{bmatrix} 2 & 6 & -4 \\ 3 & 1 & 2 \\ 5 & -3 & 7 \end{bmatrix},$$

(i)　　Determine the inverse of **A** using the co-factor method.　　　(8 marks)

(ii)　　Hence solve the following system of simultaneous equations:

$$2x + 6y - 4z = 14$$

$$3x + y + 2z = 37$$

$$5x - 3y + 7z = 66$$　　　(4 marks)

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