ICM

DECEMBER 2016

NUMBER & LOGIC

Instructions to candidates:

a) Time allowed: Three hours (plus an extra ten minutes' reading time at the start – do not write anything during this time)
b) Answer any FIVE questions
c) All questions carry equal marks. Marks for parts of questions are shown in [ ]
d) In numerical questions, candidates must show and explain the method of working to obtain full marks
e) Non-programmable calculators are permitted in this examination. Calculators should be used in all the non-binary questions. However, ensure that you write down all intermediate values obtained from a calculator. Always explain in words what you are calculating
f) Ensure that you leave numeric answers in the format required by the question
g) Ensure that you pay particular attention to words underlined, in CAPITALS or in **bold**. FEW OR NO MARKS will be awarded to any question where these are ignored
h) No computer equipment, books or notes may be used in this examination

1. a) What is $(X \cup Y) \cap Z$?
If X, Y and Z represents the sets as follows:
X = factors of 15
Y = prime numbers less than 10
Z = even numbers less than 9
Show all working [4]

b) A = The set of whole numbers less than 5
B = The set of even numbers greater than 3 but less than 9
C = The set of factors of 6
What is $(A \cap B) \cup (B \cap C)$?
Show all working [6]

c) A group of people were asked whether they use a mobile device or a laptop to send email. 25% use a mobile device, 45% use a laptop and 40% use neither.
i Draw a Venn diagram to determine the percentage of people who use both a mobile device and a laptop. [5]
ii One of the group is selected at random – find the probability that this person **only** uses a mobile device. [5]

2. P, Q and R represent the following binary integers:
P = 1001 1000 Q = 0100 0001 R = 0010 1101
Perform the following calculations IN BINARY and show **ALL** working.
For readability, clearly space out your numbers.
a) P + Q + R [3]
b) P – R [2]
c) P × R [4]
d) P / R Your answer should be accurate to 3 binary places. [4]
e) Convert P and R to decimal and show that your answers to b) and d) are correct. [4]
f) If P was a BCD representation what would be its decimal value? [3]

continued overleaf

3. a) **Using a formula**, show how you would find the sum of the following sequence:
-8, -5, -2, ..., 7 [4]

b) **Showing your working**, insert three geometric means between 1 and 81. [4]

c) Determine the smallest number of terms of the geometric progression:
8 + 24 + 72 + …
which have a total exceeding 6,00,000. [6]

d) The first six terms of an arithmetic progression total 21. The seventh term is three times the sum of the third and fourth.
i Determine the first term and the common difference.
ii Show that your answers are correct. [6]

4. a) A company uses product X in large quantities and buys a batch several times per year. Each year, 45,000 are used. One X costs £12 and, in addition, there is a handling charge of £80 for each order. A handling/ carrying cost of 15% per item is also applied. The company wishes to order as economically as possible.
i Explain what is meant by **EOQ** (Economic Order Quantity), stating what factors are taken into account.
ii Write down the formula for calculating EOQ and calculate the EOQ for this product. [8]

b) £1,000 is invested for three years at an investment rate of 5%. Calculate the additional amount this money would gain if invested at compound interest compared with simple interest. [4]

c) i Write down inequalities for the following production situation:
Products P and Q are made. Each product P takes 2 hours to make and each product Q takes 3 hours. A maximum of 300 hours are available in a given month for making these products. In addition, product P needs 30 minutes on a drilling machine and product Q needs 1 hour. The drilling machine is only available for 200 hours. [5]
ii The profit on each product P is £4, whereas on product Q it is £3. Write down a profit equation. [3]

5. a)

$$A = \begin{vmatrix} 1 & 0 & 2 \\ 3 & 4 & 5 \end{vmatrix} \qquad B = \begin{vmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{vmatrix} \qquad C = \begin{vmatrix} 4 & 5 \\ 6 & 7 \end{vmatrix}$$

i Perform matrix multiplication A × B. [3]
ii Explain why A × C is not possible. [2]
iii Write down one other possible combination of multiplying two of these matrices together. Perform this multiplication. [4]
iv Is it possible to add together any of the matrices? Give your reason. [2]

b) Write an algorithm to add two 4 × 4 square matrices. You may assume that the matrices are already held in two 2-dimensional arrays X and Y (rows 1-4, columns 1-4) and that the sum is to be placed in array Z. [5]

c) Matrices P and Q have special properties.

$$P = \begin{vmatrix} -1 & 0 \\ 0 & 1 \end{vmatrix} \qquad Q = \begin{vmatrix} 1 & 0 \\ 0 & -1 \end{vmatrix}$$

Perform the multiplications P × A and Q × A where A = $\begin{vmatrix} 3 \\ 4 \end{vmatrix}$

Show A as coordinates on a sketch graph.
State the effect of transformations **P × A** and **Q × A**. [4]

6. a) Given the data 30, 49, 44, 26, 48, 43
i determine the mean, median, range and standard deviation of this data
ii explain why mode has no meaning with this data [10]

b) Sales of a particular product over a six-month period were as follows:
100, 85, 55, 95, 75, 100
For this population, how many months' sales are within one standard deviation of the mean? [10]

continued overleaf

7. a) The hexadecimal value **40AF** is stored in Memory location X.
Showing all working, convert this value to the following:
i binary
ii octal
iii Give its **binary** value AFTER it has been divided by 8. [7]

b) The table shows how four program routines (A, B, C and D) are held in memory – all addresses are given in hexadecimal. The routines are continuous WITHOUT gaps in memory.
SHOW ALL WORKING IN THIS QUESTION.

Routine	Start address	End address	Size (hexadecimal)
A	2000	37FF	
B			
C	5400		
D	7400	AFFF	

i Copy the table and fill in the missing values. [3]
ii In the fourth column calculate, IN HEXADECIMAL, the size of each program routine. [8]

c) A second copy of routine A is loaded into memory immediately after D. Calculate the end address of this copy. [2]

8. a) For a number system with base N, write down THREE general rules or characteristics relating to that system and its arithmetic operations (e.g. relating to number of digits, carry and borrow rules). [3]
b) Explain why we use the Octal and Hexadecimal number systems in computing. [4]
c) Convert the following:
i Hex value AC4 into decimal [3]
ii Decimal 1092 into hex [3]
iii Binary string 00110010 into decimal [2]
iv Binary string 11001101 into hex [3]
v Hex value C8 into binary [2]