

**INFORMATION AND COMMUNICATION TECHNOLOGY
PAPER 2D**

Software Development

Question-Answer Book

11.15 am – 12.45 pm (1 hour 30 minutes)

This paper must be answered in English

INSTRUCTIONS

- (1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5 and 7.
- (2) Tick the appropriate box for the programming language used. **No marks will be awarded if you tick either more than one box or no boxes.**
- (3) **ANSWER ALL QUESTIONS.** Write your answers in the spaces provided in this Question-Answer book. Do not write in the margins. Answers written in the margins will not be marked.
- (4) Supplementary answer sheets will be supplied on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this book.
- (5) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Please stick the barcode label here.

Candidate Number										
Programming Language Used (Please tick one)	Pascal	<input type="checkbox"/>								
	C	<input type="checkbox"/>								
	Visual Basic	<input type="checkbox"/>								
	Java	<input type="checkbox"/>								



- (b) The following algorithm ALG2 processes P and Q, which are integer arrays with indices from 1 to n. The integers in the arrays are sorted in descending order. X is an integer array with indices from 1 to (n+n).

ALG2

Step 1: $i \leftarrow n ; j \leftarrow n ; k \leftarrow 1$
 Step 2: while $k \leq (n+n)$ do steps 3 to 10
 Step 3: if $j=0$
 Step 4: then $X[k] \leftarrow P[i]$ and $i \leftarrow i - 1$
 Step 5: else if $i=0$
 Step 6: then $X[k] \leftarrow Q[j]$ and $j \leftarrow j - 1$
 Step 7: else if $P[i] < Q[j]$
 Step 8: then $X[k] \leftarrow P[i]$ and $i \leftarrow i - 1$
 Step 9: else $X[k] \leftarrow Q[j]$ and $j \leftarrow j - 1$
 Step 10: $k \leftarrow k + 1$

Suppose $n = 6$. The initial contents of P and Q are shown below. Dry run ALG2.

P[1]	P[2]	P[3]	P[4]	P[5]	P[6]
12	10	9	6	2	1

Q[1]	Q[2]	Q[3]	Q[4]	Q[5]	Q[6]
11	8	7	5	4	3

- (i) What are the final contents of X[1] and X[12]?

X[1]

X[12]

- (ii) How many times will the statement in Step 3 be executed? _____

- (iii) Simplify Steps 3 to 9 in one single 'if-then-else' statement.

(6 marks)

2. The algorithm CAL processes the operation of an arithmetic expression stored in an array N. N contains integers and symbols '(', ')', '+', and '-'. CAL makes use of the following operations on the stack S:

push(K, S) puts the element K on the top of S
pop(S) removes and returns the element from the top of S.

CAL

Step 1: Initialise S to empty
Step 2: $i \leftarrow 1$
Step 3: while N[i] is not empty do steps 4 to 12
Step 4: if N[i] = ')' then do Steps 5 to 10
Step 5: A \leftarrow pop(S)
Step 6: B \leftarrow pop(S)
Step 7: C \leftarrow pop(S)
Step 8: temp \leftarrow pop(S)
Step 9: If B = '+' then push(C + A, S)
Step 10: else push(C - A, S)
Step 11: else push(N[i], S)
Step 12: i \leftarrow i + 1
Step 13: Output pop(S)

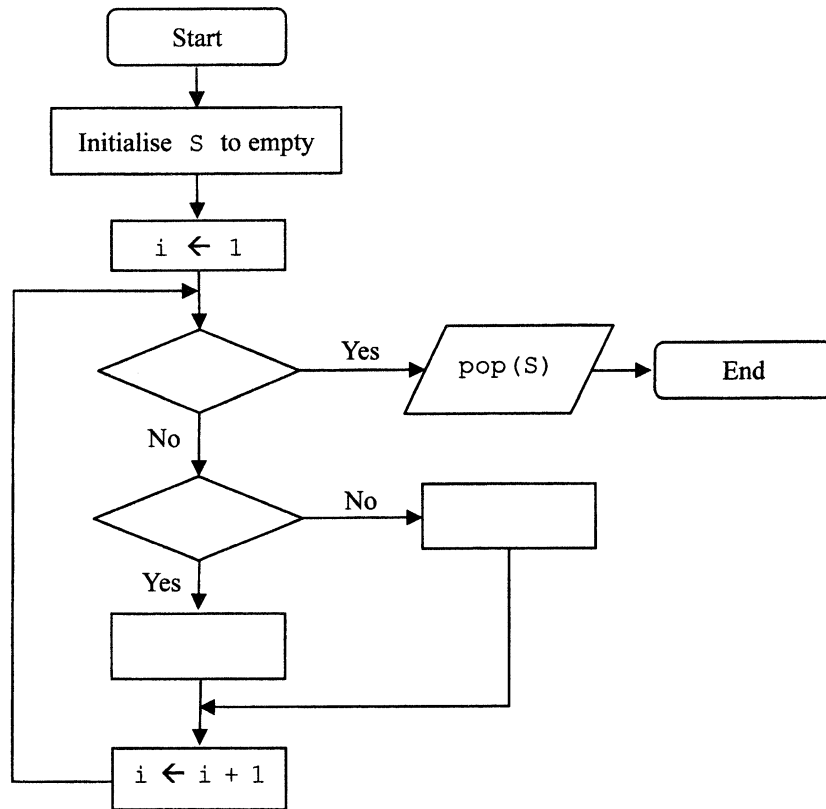
- (a) CAL is an algorithm that will be implemented as a program and executed many times in a computer system. What translator should be used? Justify your answer.

(2 marks)

- (b) Choose four statements from the following statements ① to ⑥ to complete the flowchart of CAL below.

- ① The symbol is '+'?
- ② Insert the symbol to S
- ③ N[i] is empty?
- ④ Do the arithmetic and insert the result in S
- ⑤ N[i] = ')'?
- ⑥ Remove an element from S

Answers written in the margins will not be marked.



(4 marks)

(c) The initial content of N is given below.

$N[1]$	$N[2]$	$N[3]$	$N[4]$	$N[5]$	$N[6]$	$N[7]$	$N[8]$	$N[9]$	$N[10]$
(	(	2	+	3	)	-	4)	

Dry run CAL and write the content of S below.

In Step 12,

when i is changed from 5 to 6

← Bottom of S

when i is changed from 6 to 7

← Bottom of S

(4 marks)

- (d) Suppose that S is implemented by an array, the content of N is valid and the size of N is 10. What is the minimum size of S ?

(2 marks)

- (e) The following three sets of test cases will be used for testing CAL.

Test case	N[1]	N[2]	N[3]	N[4]	N[5]	N[6]	N[7]	N[8]	N[9]
A1	(	1	+	2)				
A2	(	1	-	2)				
A3	(	(	1	-	2	)	+	3)

Test case	N[1]	N[2]	N[3]	N[4]	N[5]	N[6]	N[7]	N[8]	N[9]
B1	1	+	2)					
B2	(	1	+	2))			
B3	(	1	+	2	)	+	3		

Test case	N[1]	N[2]	N[3]	N[4]	N[5]	N[6]	N[7]	N[8]	N[9]
C1									
C2	1								

State the different uses of the three sets of test cases.

Set A: _____

Set B: _____

Set C: _____

(3 marks)

Answers written in the margins will not be marked.

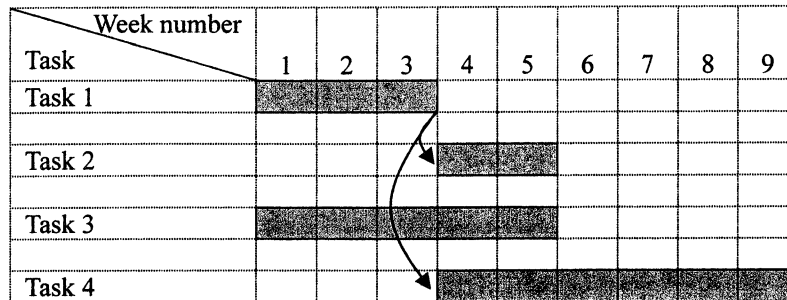
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Please stick the barcode label here.

3. Mr Li works on a project to develop an online auction system. Users can submit auction item information to create an auction entry or bid an auction item through the system.

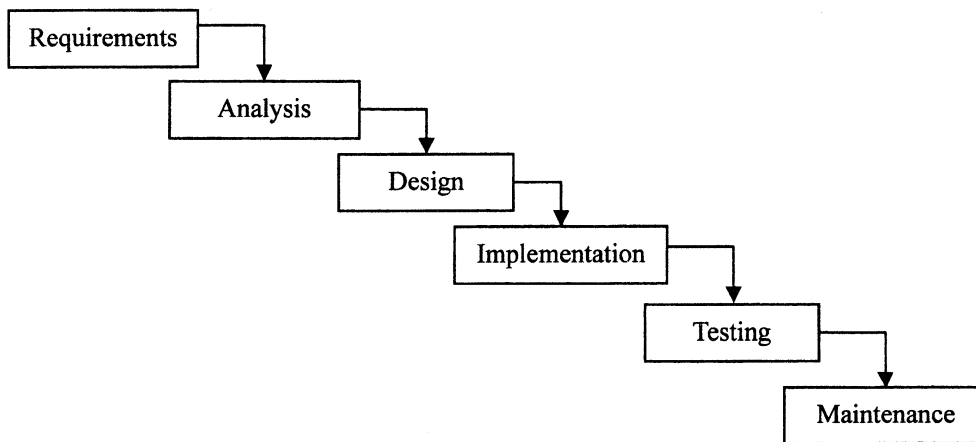
(a) Mr Li creates a Gantt chart for the project, as shown below.



- (i) How many weeks does Mr Li plan to take to complete the project? _____
- (ii) What is the relationship between Task 1 and Task 2 in the Gantt chart?

(2 marks)

In systems development, Mr Li uses the following Waterfall Model.



- (b) In the Testing phase, Mr Li finds that the system cannot pass the user acceptance test. In which phrase(s) could a mistake have been made? How can he find out?

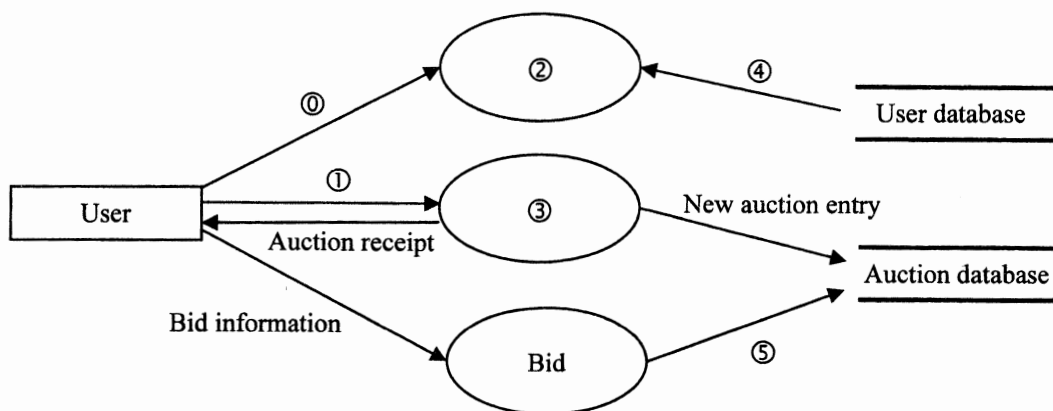
(3 marks)

Answers written in the margins will not be marked.

(c) Mr Li constructs a data flow diagram to represent the flow of data within the online auction system.

(i) Referring to the Waterfall model above, in which phase should the data flow diagram be created?

(ii) Complete the data flow diagram of the online auction system below. Write down the numbers of the items.



<u>Item</u>	<u>Number</u>
Username/password	①
auction item information	
Biding entry	
Create auction	
Authentication	
User information	

(6 marks)

Answers written in the margins will not be marked.

- (d) Given that myRAND is a subprogram which randomly returns an integer between 1 and 1000 inclusively, Mr Li designs the following algorithm R1 to randomly select one auction item.

R1

Step 1: $n \leftarrow$ number of auction items
Step 2: $i \leftarrow$ remainder of $(\text{myRAND}() \div n) + 1$
Step 3: return the i -th item

- (i) Write myRAND in Pascal, C, Visual Basic or Java so that the computer will return different random numbers every time myRAND is executed.

- (ii) Mr Li finds that some auction items could never be selected by R1. What would the total number of auction items be?

- (iii) Mr Li finds that some auction items could be selected more often than the others by R1. What would the total number of auction items be?

(5 marks)

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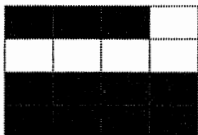
4. Mary uses a software package to store some black and white images of 4×4 pixels as text files. The software package has Method 1 and Method 2 to store the images, as described below. In both methods, '1' and '0' represent a black pixel and a white pixel respectively.

Method 1: An image is stored as a text file containing 4×4 characters of '1's and '0's. Each pixel of the image is represented by the corresponding character in the file.

Method 2: An image is scanned from the top row, left to right. Sets of two numbers (P, Q) in the text file are used to represent the pixels where P is the digit '1' or '0' (black/white pixel) and Q is the number of consecutive digits.

Example 1 shows how the software package stores an image.

Example 1



Method 1

1	1	1	0
0	0	0	0
1	1	1	1
1	1	1	1

Method 2

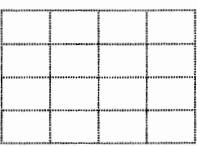
1	3
0	5
1	8

(a) An image is stored by Method 2, as shown below. Shade the black pixels of the image on the right hand side.

Method 2

0	4
1	2
0	2
1	2
0	6

Image



(2 marks)

(b) (i) With respect to file size, describe a best case and a worse case of images stored by Method 2.

Best case: _____

Worst case: _____

(ii) Other than file size, give an advantage of Method 1 over Method 2.

(3 marks)

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- (c) An image is saved as a text file using Method 1 and the data in the text file is stored in a global two-dimensional array BD. The array items of BD with the indices (1, 1) and (4, 4) store the digits in the top left hand corner and the bottom right hand corner respectively.

Mary wants to write a subprogram ENC to save the image as a text file using Method 2 with BD using the following variables for storing the data in the text file.

Variable	Description
P	A global integer array for storing the first value in each set of (P, Q)
Q	A global integer array for storing the second values in each set of (P, Q)

In Example 1,

Pascal / C / Java versions	Visual Basic version
P[1] = 1, Q[1] = 3	P(1) = 1, Q(1) = 3
P[2] = 0, Q[2] = 5	P(2) = 0, Q(2) = 5
P[3] = 1, Q[3] = 8	P(3) = 1, Q(3) = 8

- (i) Complete ENC.

[Pascal version]

```

procedure ENC;
var
  i, j, k, current : integer;
begin
  k := 1;
  P[1] := BD[1,1];
  Q[1] :=  ;
  current :=  ;
  for i := 1 to 4 do
    for j := 1 to 4 do
      if (BD[i,j] =  ) then
        Q[k] := Q[k] + 
      else begin
        k := k + 1;
        P[k] := BD[i,j];
        Q[k] :=  ;
        current := BD[i,j];
      end;
    end;
  end;
end;

```

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[C version]

```

void ENC() {
int i, j, k, current;
    k = 1;
    P[1] = BD[1][1];
    Q[1] =  ;
    current =  ;
    for (i=1; i<=4; i++)
        for (j=1; j<=4; j++)
            if (BD[i][j] == )
                Q[k] = Q[k] +  ;
            else {
                k++;
                P[k] = BD[i][j];
                Q[k] =  ;
                current = BD[i][j];
            }
}

```

[Visual Basic version]

```

Sub ENC()
Dim i, j, k, current As Integer
    k = 1
    P(1) = BD(1,1)
    Q(1) = 
    current = 
    For i = 1 to 4
        For j = 1 to 4
            If BD(i,j) =  Then
                Q(k) = Q(k) + 
            else
                k = k + 1
                P(k) = BD(i,j)
                Q(k) = 
                current = BD(i,j)
            End If
        Next j
    Next i
End Sub

```

[JAVA version]

```
void ENC() {
int i, j, k, current;
    k = 1;
    P[1] = BD[1][1];
    Q[1] = ;
    current = ;
    for (i=1; i<=4; i++)
        for (j=1; j<=4; j++)
            if (BD[i][j] == )
                Q[k] = Q[k] + ;
            else {
                k++;
                P[k] = BD[i][j];
                Q[k] = ;
                current = BD[i][j];
            }
}
```

- (ii) Mary wants to reduce the memory usage of ENC. She thinks that it can be rewritten such that only the first element in P is required. In other words, the other elements in P are not required. Do you agree? Explain briefly.

(7 marks)

- (d) Mary considers using object-oriented language or procedural language to write this subprogram. Give one advantage of each kind of programming language for performing this task.

Object-oriented language:

Procedural language:

(2 marks)

END OF PAPER