



福建中學

FUKIEN SECONDARY SCHOOL

S6 Mock Examination (2020-2021)
Information and Communication Technology
Paper 2D
Software Development
Question-Answer Book
(1 hour 30 minutes)

Date: 21st January 2021

Time: 11:00 a.m. - 12:30 p.m.

Name: _____

Class: _____ No.: _____

INSTRUCTIONS

1. Write your name, class and class number on the spaces provided.
2. **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. Supplementary answer sheets will be supplied on request.

Answer all questions.

1. (a) The following algorithm, ALG1, processes a non-negative integer variable, N , and stores the results in an array, X , with indexes from 1 to 6.

ALG1

Step 1: Initialise each element in X with a value 0.

Step 2: $i \leftarrow 0$

Step 3: While $N \geq 1$ do Steps 4 to 6

Step 4: $X[6 - i] \leftarrow$ remainder of $(N / 2)$

Step 5: $N \leftarrow$ integral part of $(N / 2)$

Step 6: $i \leftarrow i + 1$

- (i) Suppose $N = 29$. Dry run ALG1.

(1) Fill in the contents of X .

$X[1]$	$X[2]$	$X[3]$	$X[4]$	$X[5]$	$X[6]$

(2) How many iterations of the loop will be executed?_____

- (ii) What is the range of the values of N that ALG1 can process without causing an error? Explain briefly.

- (iii) Study the pattern of the values in X in (a)(i). What is the purpose of ALG1?

(6 marks)

- (b) The following algorithm, ALG2, processes a non-negative integer variable, N , and stores the results in an array, Y , with indexes from 1 to 6. N is smaller than 64.

ALG2

Step 1: Initialise each element in Y with a value 0.

Step 2: $j \leftarrow 1$

Step 3: While $N > 0$ do Steps 4 to 7

Step 4: If $N \geq Z[j]$ Then do Steps 5 to 6

Step 5: $Y[j] \leftarrow 1$

Step 6: $N \leftarrow N - Z[j]$

Step 7: $j \leftarrow j + 1$

Z is an array with the following initial values.

Z[1]	Z[2]	Z[3]	Z[4]	Z[5]	Z[6]
32	16	8	4	2	1

(i) Suppose $N = 48$. Dry run ALG2. Fill in the content of Y.

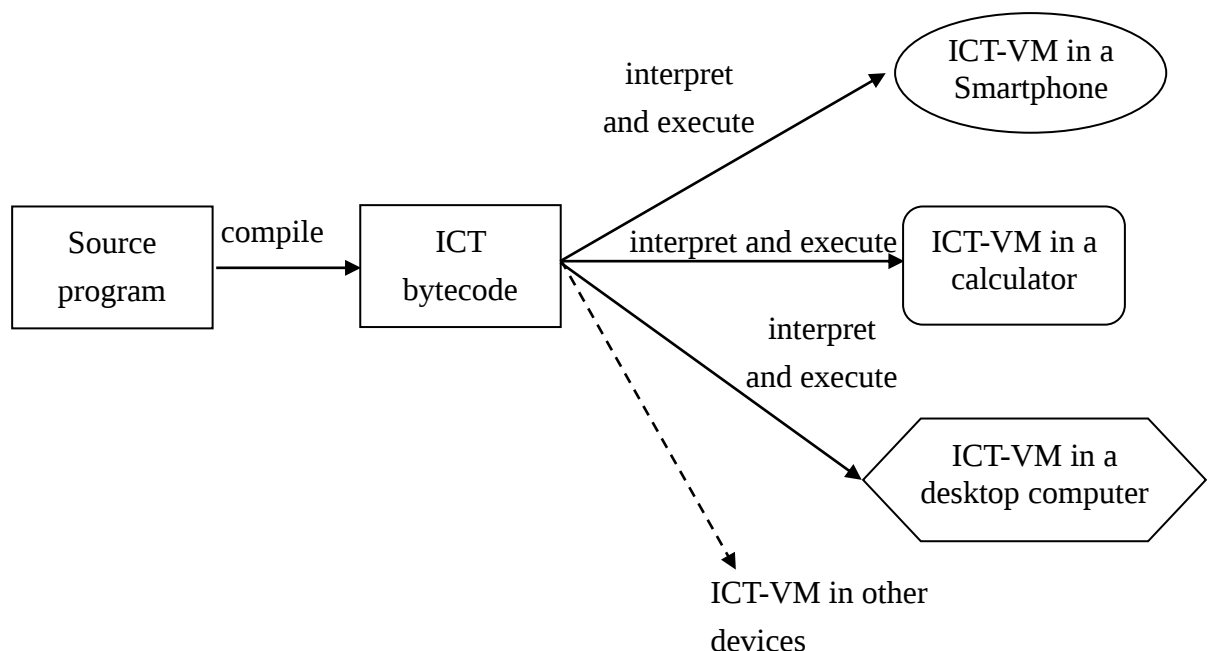
Y[1]	Y[2]	Y[3]	Y[4]	Y[5]	Y[6]

(ii) In the worst case, how many iterations of the loop will be executed?

(iii) Give a value of N ($N > 0$) and show that ALG2 will execute fewer iterations than ALG1 does.

(6 marks)

(c) ALG2 is implemented by a programming language called 'ICT'. The source program will be compiled to an 'ICT bytecode' which is machine independent. An 'ICT virtual machine' (ICT-VM) will be used to interpret and execute the 'ICT bytecode' whenever the program is executed. The diagram below shows this process.



(i) Referring to the above diagram, suggest an advantage of using 'ICT bytecode'.

(ii) Suppose machine code is used instead of 'ICT bytecode'.

(1) The process will change. Describe the new process briefly.

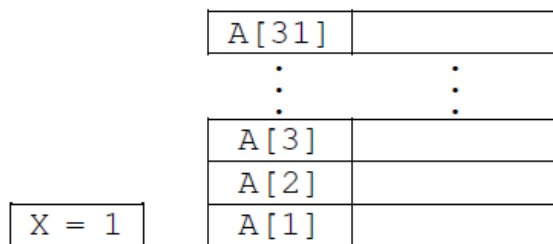
(2) What is the advantage of this change?

(3 marks)

2. A company installs a smart card attendance system. When entering the company, each staff member taps his or her smart card on a card reader and the arrival time will be stored in a stack in the smart card.

(a) The stack can store a maximum of 31 data items on arrival time. It is implemented by an array, A, with an integer variable X. X stores the index of the next available array element for the stack. X stores 32 when A is full. A[1] is the first element.

The stack is initialised at the beginning of each month so that all data items in the stack are removed and $x = 1$.



(i) RET(A) is a subprogram that retrieves a data item on arrival time and removes it from A. Suppose that a smart card has stored the arrival time for the first 19 days. In order to retrieve the arrival time of the 4th day, how many times should RET(A) be called? What is the value of X after the calls?

RET(A) will be called _____ times; $X =$ _____

(ii) An extra stack is needed for the operation in (a)(i).

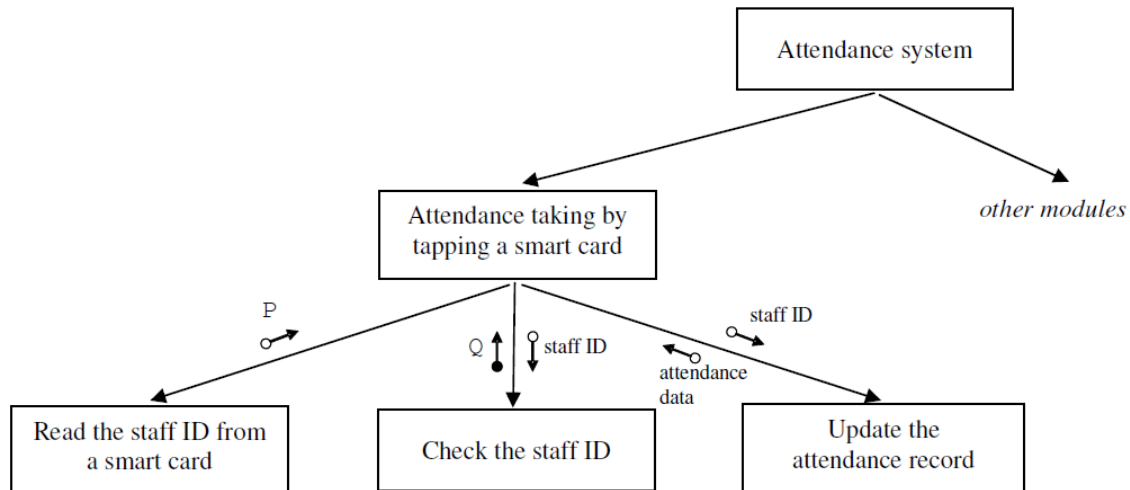
(1) What would happen if only A were used?

(2) How is the extra stack used in the operation?

(iii) If the stack continues to be used next month without initialisation, what will happen?

(6 marks)

(b) Each smart card is identified by a staff ID. Some modules in this attendance system are shown in the structure chart below.



The symbol  represents data that is passed between modules. The symbol  represents information resulted from a validation test.

(i) What is P?

(ii) What is Q? Briefly describe how Q is used.

(3 marks)

(c) The company hires a software company to develop the attendance system.

(i) The software company carries out a user acceptance test, system test and unit test before the delivery of the system.

(1) Which test should be carried out first? _____

(2) Which test should be carried out last? _____

(3) State the main purpose of each kind of test.

User acceptance test: _____

System test: _____

Unit test: _____

(ii) The company adopts a direct cutover approach to converting the system.

(1) What is the major risk of this approach?

(2) Why does the company choose to adopt this approach despite the risk?

(7 marks)

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.

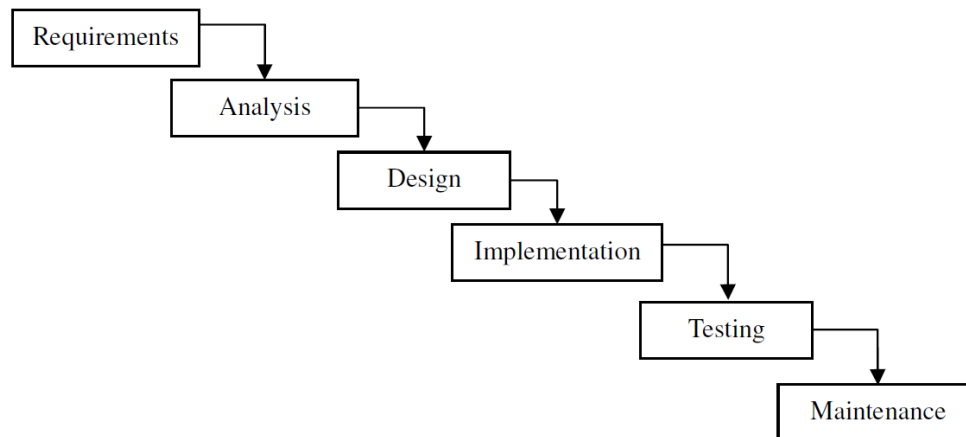
Week number	1	2	3	4	5	6	7	8	9
Task 1									
Task 2									
Task 3									
Task 4									

(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.



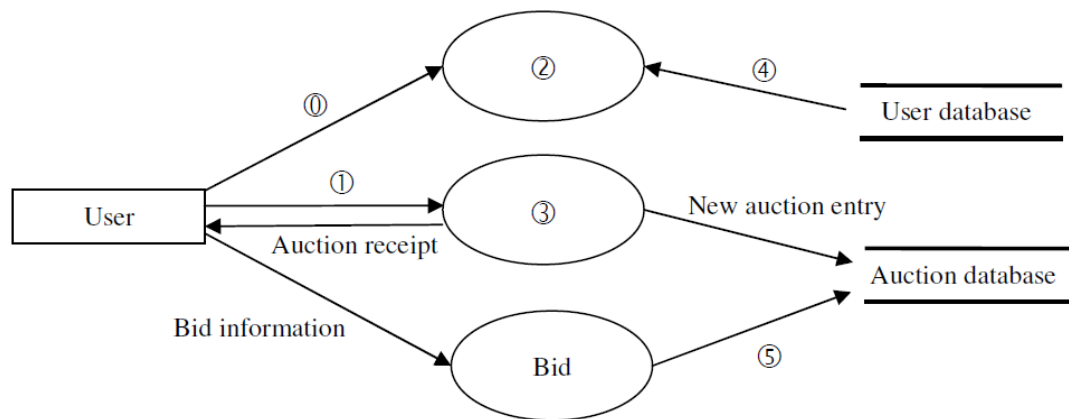
- (b) In the Testing phase, Mr Li finds that the system cannot pass the user acceptance test. In which phase(s) could a mistake have been made? How can he find out?

(2 marks)

(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)

(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?
-
-

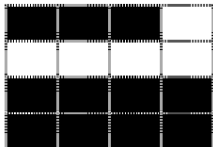
(5 marks)

4. Mary uses a software package to store some black and white images of 4x4 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 4x4 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.

	<u>Image</u>	<u>Method 1</u>	<u>Method 2</u>																						
Example 1		<table data-bbox="722 1057 935 1202"><tr><td>1</td><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table>	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1	<table data-bbox="1034 1057 1177 1236"><tr><td>1</td><td>3</td></tr><tr><td>0</td><td>5</td></tr><tr><td>1</td><td>8</td></tr></table>	1	3	0	5	1	8
1	1	1	0																						
0	0	0	0																						
1	1	1	1																						
1	1	1	1																						
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)

- (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 comer and the bottom right hand comer 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,

C versions
P[1] = 1, Q[1] = 3
P[2] = 0, Q[2] = 5
P[3] = 1, Q[3] = 8

(i) Complete ENC.

```
[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];
            }
}
```

- (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