福建中學

FUKIEN SECONDARY SCHOOL

S6 Mock Examination (2021-2022)
Information and Communication Technology
Paper 2D
Software Development
(1 hour 30 minutes)

Date: 27th January 2022 Name:_____
Time: 11:00a.m. - 12:30p.m. Class: _____ No.: _____

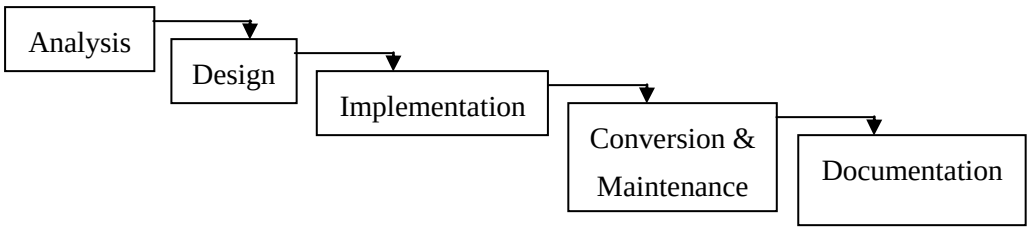
INSTRUCTIONS

1. Write your name, class and class number on the spaces provided.
2. Answer **THREE** out of four questions.

Answer THREE questions only.

1. Mary is a system analyst and she works for a new self-checkout system in a supermarket.

   (a) She plans to use waterfall model to develop the system.



   (i) State **two** phases that the users will **not** be involved.

_____

(2 marks)

   (ii) Mary plans to have three types of testing during the Implementation phase as below:

Test case	Details
1	The supermarket manager checks for the functionality of the whole system according to the requirement.
2	Testing whether the barcode can be scanned for obtaining the product ID.
3	Testing the integration of the checkout system with the stock system.

What types of testing are they?

Test case 1: _____

Test case 2: _____

Test case 3: _____

(3 marks)

   (iii) High-level programming language and assembly language can be adopted for developing the system. Suggest one benefit for each of the languages.

_____

_____

_____

(2 marks)

(iv) Tom suggests using RAD instead of waterfall model to develop the system. State one reason to support him.

_____

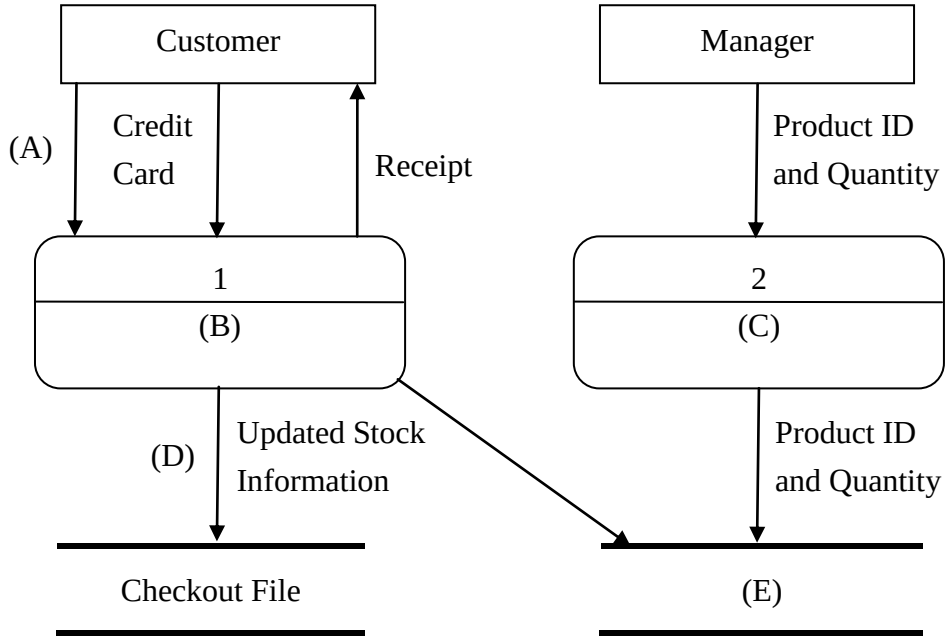
_____

(1 mark)

(b) During the design phase, a Data Flow Diagram (DFD) is used to illustrate the design of the whole system in the supermarket.

A customer can use self-checkout system to buy goods. He should first scan the barcode to input the product ID and present the credit card for the payment. The self-checkout system will return a receipt to the customer. It updates the checkout file with the checkout information and update the stock file with the updated stock information.

The manager can update the stock files through the stock system by inputting the product ID and quantity.



(i) Fill in the blanks to complete the Data Flow Diagram.

(A) _____ (B) _____

(C) _____ (D) _____

(E) _____

(5 marks)

(ii) Other than Data Flow Diagram, suggest another chart that can be included in the Design phase.

_____

(1 mark)

(iii) Mary wants to include this chart into the user manual. Do you agree? Explain briefly.

_____

_____

_____

(1 mark)

2. Mary creates a linked list to represent how multiple units in a train are linked. Each unit is named by an alphabet. She uses parallel arrays to implement the linked list. Array `UNIT` stores the name of the unit. Array `NEXT` stores the address of the next node. The first node in `UNIT` stores `START`.

(a) `LL1`

Address	UNIT	NEXT
0	START	4
1	A	-2
2	B	1
3	C	7
4	D	3
5	E	-2
6	F	2
7	G	6
8	H	5

(i) Other than linked list, suggest another data structure and state the major difference while inserting a new element.

_____

_____

(ii) What is the purpose of using -2 as a location of next unit?

_____

_____

(iii) Other than -2, what are other possible values that Mary can use?

_____

_____

(iv) Write down the content of next four nodes after `START` in order.

_____

(v) How many nodes are there in this linked list excluding the first node `START`?

_____

(7 marks)

(b) Suppose the sequence of units is `A`→`F`→`G`→`C`→`E`→`B`→`D`→`H`. Fill in the missing column `NEXT` in `LL2`.

`LL2`

Address	UNIT	NEXT
0	START	1
1	A	
2	E	
3	F	
4	B	
5	D	
6	C	
7	G	
8	H	

(2 marks)

(c) Mary designs another structure by adding another array PREV. In each node, PREV points to the previous node, as shown in the following example.

LL3

Address	UNIT	PREV	NEXT
0	START	-1	4
1	A	2	5
2	E	6	1
3	F	4	7
4	B	0	3
5	D	1	8
6	C	7	2
7	G	3	6
8	H	5	-2

(i) Give one advantage of adding PREV to the structure.

_____

_____

(1 mark)

(ii) Mary designs an operation DELETE(Z) that will delete the node with address Z. Update LL3 after executing DELETE(6).

LL3

Address	UNIT	PREV	NEXT
0	START		
1			
2			
3			
4			
5			
6			
7			
8			

(3 marks)

(iii) The `LL3` is implemented by parallel arrays `UNIT`, `PREV` and `NEXT`. For example, `UNIT[8]` stores `H`, `PREV[8]` stores 5 and `NEXT[8]` stores -2. Assume that `Z` is not the start node or the end node of the linked list, complete the following algorithm for the operation `DELETE[Z]`.

```
DELETE(Z):
NEXT[PREV[Z]] ← _____________________
PREV[NEXT[Z]] ← _____________________
```

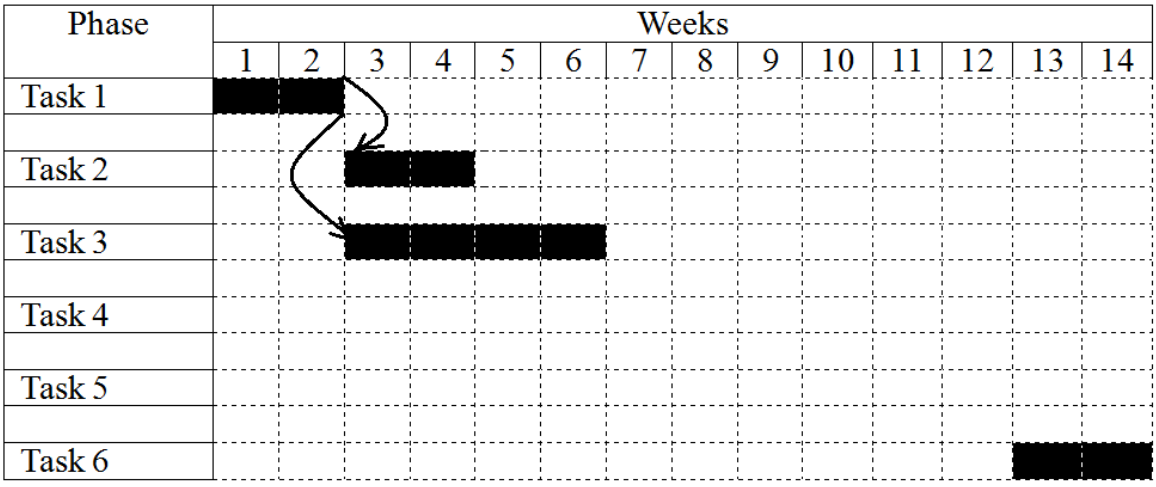
(2 marks)

3. Mary is a project manager. She is planning the development of Academic Calculation System. The development work involves 5 major tasks. The following table shows the durations and dependencies of the tasks.

Task	Number of weeks needed	The task(s) it depends on
1	**2**	**--**
2	**2**	**1**
3	**4**	**1**
4	**4**	**5**
5	**4**	**2**
6	**2**	**4,5**

Task 1 is Requirement and Analysis phase, Tasks 2 and 3 are Design phases, Task 5 is Implementation and Task 6 is Conversion.

(a) (i) Complete the Gantt chart below.



(3 marks)

(ii) Which phase is Task 4 in system development lifecycle?

_____

(1 mark)

(iii) What is the critical path of the project?

_____

(1 mark)

(iv) What is the minimum number of weeks needed to complete the project if Mary decides to reduce the duration of Task 1, Task 2 and Task 4 by one week?

_____

(1 mark)

(v) Mary decides to use Waterfall model instead of RAD. Give one advantage of using Waterfall model.

_____

_____

(1 mark)

(b) The following algorithm CAL1 processes an integer array A with index from 0 to n-1.

CAL1

```
Step 1:   d ← 0
Step 2:   e ← 0
Step 3:   for i from 0 to n-1 do steps 4 to 10
Step 4:       c ← 0
Step 5:       for j from 0 to n-1 do steps 6 to 7
Step 6:           if A[i] = A[j] then do step 7
Step 7:               c ← c+1
Step 8:       if c > d then do steps 9 to 10
Step 9:           d ← c
Step 10:          e ← i
Step 11:  Output A[e]
```

Suppose n = 10. The initial content of A is shown below.

A[0]	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]	A[9]
47	64	49	50	50	70	49	50	70	64

(i) Dry run CAL1. Fill in the values of d and e after completing steps 4 to 10 when

(1) i = 1

d = _____ e = _____

(1 mark)

(2) i = 4

d = _____ e = _____

(1 mark)

(ii) How many times will the statement in Step 9 totally be executed after the third pass of the loop in Step 3?

_____

(1 mark)

(iii) What is the purpose of algorithm CAL1?

_____

(1 mark)

(iv) Algorithm `CAL1` will be executed for many times. Complied language or Interpreted language, which one should you choose? Explain your answer briefly.

_____

_____

(2 marks)

(v) The following sets of test cases will be used for testing `CAL1`.

Set A

A[0]	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]	A[9]
47	47	47	47	47	47	47	47	47	47

Set B

A[0]	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]	A[9]
47	89	64	37	45	78	20	56	42	60

State the use of the above test cases and explain why we need to set the above test cases.

_____

_____

_____

_____

(2 marks)

4. Laser cutting is a technology that makes use of a laser beam to slice materials. Laser cutting is done by directing the high-power laser onto a material (Fig 4.1). A driver program with a control system is used to control the movement of the laser head and power of the laser beam. Different powers of laser-beam are used to serve different purposes. A low power laser can burn a mark on the material. A high power laser can slice it.

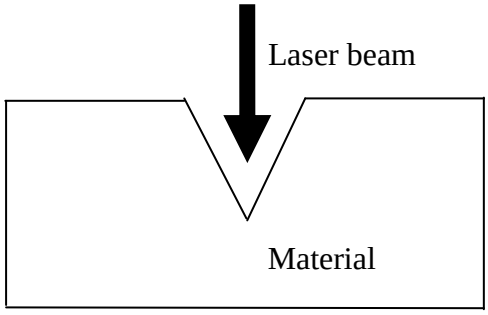


Fig 4.1

The control system uses various subprograms and variables to carry out the laser cutting process. Some of them are given below.

Subprogram	Description
`LaserOn()`	Turn on the laser beam
`LaserOff()`	Turn off the laser beam
`MoveLH(x, y)`	Move the laser head to the position `(x, y)`

Variable	Description
`i, j`	Integer variables for iterations
`x, y`	The x-coordinate and y-coordinate of a point

(a) A subprogram `DrawSquare1(x, y, length)` is used to draw a filled square with the bottom left point at `(x, y)` and the length of the square is `length`.

Complete the pseudo-code of `DrawSquare1(x, y, length)`

```
DrawSquare1(x, y, length){
    MoveLH(x, y)




}
```

(3 marks)

(b) Make use of the subprogram in software development increases modularity. State **two** advantages of modular programming.

_____

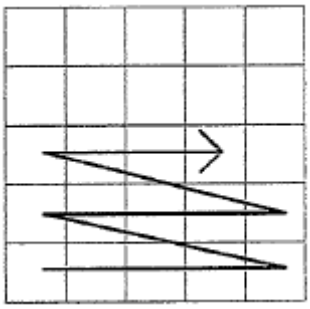
_____

_____

_____

(2 marks)

The laser head moves in a zigzag pattern in cutting.



The pattern to be cut is stored in an image file. The driver program loads the file and stores it in an integer array `Pattern[i, j]`. The numbers are cutting sequence number to denote the order to be cut. Continuous cutting points are marked as the same sequence number. The number 0 is used to denote the point does not need to be cut.

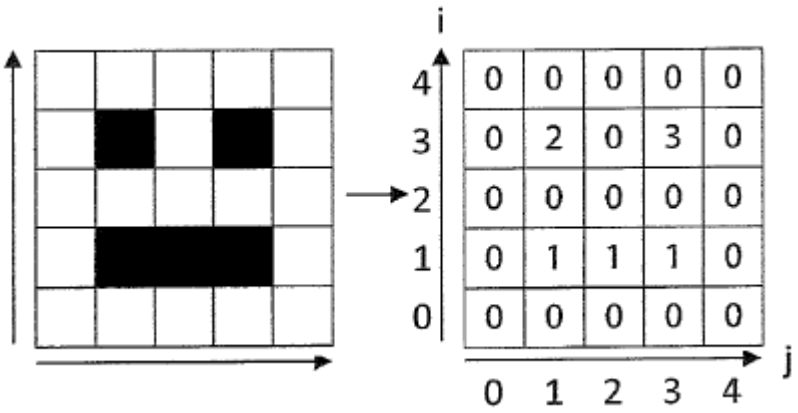


Fig 4.2

(c) Before cutting the pattern, the driver program loads the image file and convert it to an array. The raw data in an image file is in a linear format, which is good for data processing but cannot be used for laser-cutting easily. The driver program reads the file and stores the data in an integer array `Image[]`. For the image file in Fig 4.2, `Image[]` stores the data as shown in the following format:

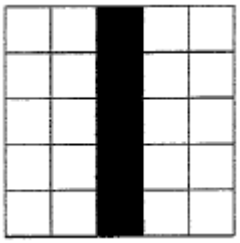
Image[i]	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0
i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Fig 4.3

The dimension of this pattern is 5×5. For every 5 elements in `Image[]`, it will be mapped to one row of `Pattern[i, j]`. For example, the first 5 elements of `Image[]`, that is `Image[0]` to `Image[4]` are mapped to the first row of `Pattern[i, j]`, that is `Pattern[0,0]`, `Pattern[0,1]`, `Pattern[0, 2]`, `Pattern[0, 3]` and `Pattern[0, 4]`, as shown in Fig 4.2.

Write down the content in `Image[]` for each of the following patterns. Array elements with 0 can be omitted.

(i) Image file:



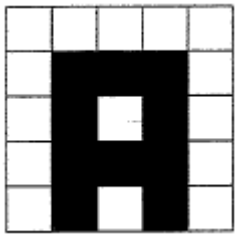
`Image[]`:

Image[i]										
i	0	1	2	3	4	5	6	7	8	9

Image[i]										
i	10	11	12	13	14	15	16	17	18	19

Image[i]					
i	20	21	22	23	24

(ii) Image file:



Image[]:

Image[i]										
i	0	1	2	3	4	5	6	7	8	9

Image[i]										
i	10	11	12	13	14	15	16	17	18	19

Image[i]					
i	20	21	22	23	24

(2 marks)

More variables in the control system of the laser cutter are given:

Variable	Description
`Width, height`	Global variables that represent the width and height of the pattern to be cut.
`Pattern[i, j]`	A global integer array of the cutting pattern in 2-dimension format.
`Image[i]`	A global integer array of the cutting pattern in a linear format.
`current`	An integer variable to store the current cutting sequence number.
`index`	An integer variable to store the index of `image[]` of the current cutting point.

(d) A subprogram `mapping()` is used to convert the two-dimensional array `Pattern[i, j]` to the linear array `Image[]`.

Complete the pseudo-code of `mapping()`.

```
Mapping(){
    for j from 0 to __________ do
        for i from 0 to __________ do
            ____________________ ← Pattern[i, j]
```

(2 marks)

(e) A subprogram `findNextPt(current, index)` is used to find the next point to be cut in `Image[]`. `Image[index]` is the current cutting point. The integer variable `current` stores the current cutting sequence number.

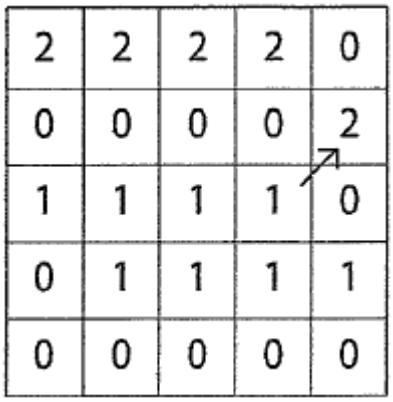


Fig 4.4

In Fig 4.4, after cutting the last element of sequence 1, the program searches for and move to the first element of sequence 2.

(i) Complete the pseudo-code of `findNextPt(current, index)` that return the `index` of the next point to be cut by using linear search. Return -1 if the next point cannot be found.

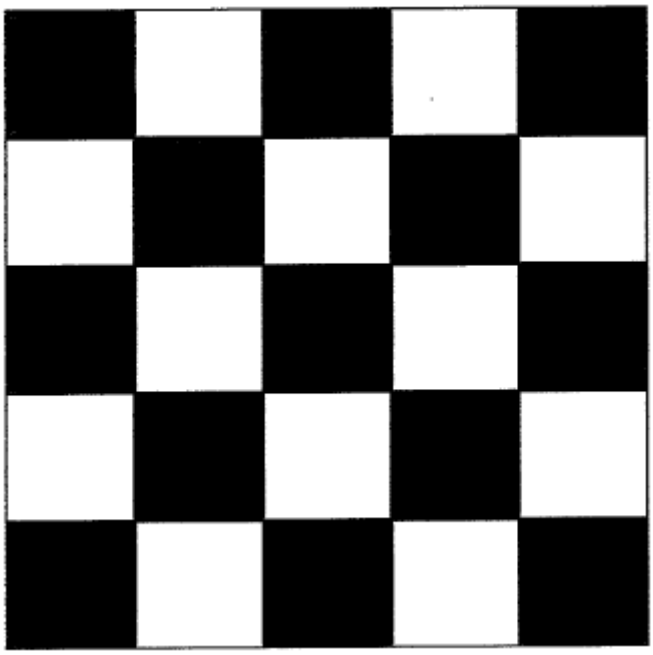
```
findNextPt(current, index){




}
```

(4 marks)

(ii) Chris uses the laser cutter to cut the following pattern:



He states that binary search is more efficient than linear search for the subprogram `findNextPt`. Do you agree with him in this case? Justify your answer.

_____

_____

_____

_____

_____

(2 marks)

END OF PAPER