2016-DSE
CT
APER 2D

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

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

Please stick the barcode label here.

Candidate Number									
Programming Language Used (Please tick one)	Pascal ☐	C ☐	Visual Basic ☐	Java ☐					

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.

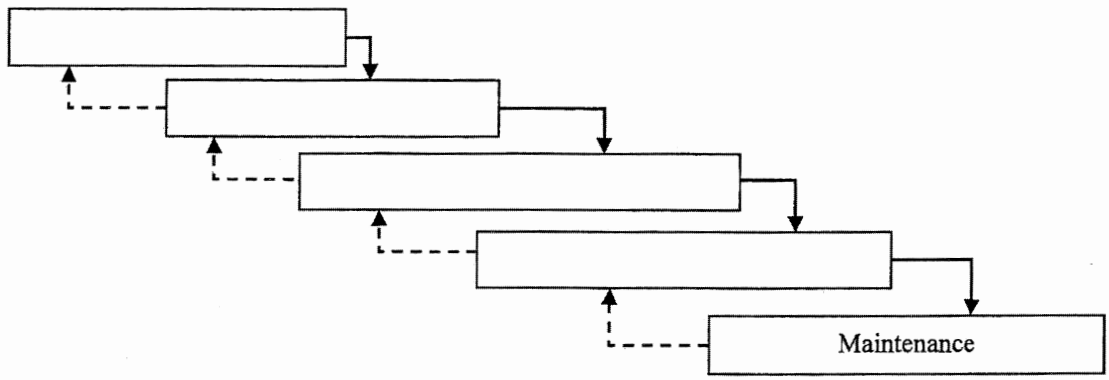
Answer all questions.

1. Typing words using a keyboard may wrongly reverse two adjacent characters, for example, 'sequence' may be typed as 'sequecne'. Tony wants to develop a typing correction system (TCS) to correct this kind of typing error.

(a) `CmpRStr` is the core subprogram in TCS. Tony is going to develop `CmpRStr` using the Waterfall Model.

(i) Fill in the following stages in the Waterfall Model.

(1) Integration
(2) Design
(3) Requirements
(4) Implementation



(ii) In which stage should the selection of algorithms be done? _____

(iii) In which stage can `CmpRStr` be executed independently? _____

(iv) Tony had considered using Rapid Application Development (RAD). Give one limitation of RAD.

_____

_____

(7 marks)

(b) After compiling `CmpRStr`, linkers and loaders will be involved. Describe the major functions of linkers and loaders.

Linkers: _____

_____

_____

Loaders: _____

_____

_____

(4 marks)

Answers written in the margins will not be marked.

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`CmpRStr(S, T)` is the core subprogram in TCS and its pseudocode is shown below. `S` and `T` are arrays that store two strings. Assume that the index of the first character in `S` and `T` are 0.

```
CmpRStr(S, T)
 len ← length of S
 count ← 0
 if len = length of T then
       j ← 0
       while j < len-1 do
            if S[j] ≠ T[j] then
                 if (S[j] = T[j+1]) and (S[j+1] = T[j]) then
                      count ← count + 1
                      j ← j + 1
                 else
                      count ← -1
                      j ← len
            j ← j + 1
       if j = len-1 then
            if S[len-1] ≠ T[len-1] then
                 count ← -1
       return count
 else return -1
```

(c) Write down the return values of `CmpRStr` for the following values of `S` and `T`.

S	T	Return value of CmpRStr
banana	banna	
banana	canana	
banana	abanan	
banana	banank	

(4 marks)

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Answers written in the margins will not be marked.

2. Mr Chan plans to develop a mobile application for a restaurant. Guests can make table reservations through the mobile application and then receive a notification when their seats are ready. Mr Chan uses the following variables and functions to manage the reservations made by waiting guests:

Variable/function	Description
`A`	an array with indexes from `0` to `n-1`
`start`	a variable for storing the position of the first waiting guest in `A`
`next`	a variable for storing the position for the new guest in `A`
`addG(name)`	a subprogram that adds the name of a new guest `name` to `A` if the number of waiting guests is smaller than `n`
`removeG`	a subprogram that returns the name of the first waiting guest in `A` and removes the name from `A` if `A` is not empty

For example, assume that `n = 8` and no guest is waiting.

`start = 0, next = 0`

i	0	1	2	3	4	5	6	7
the i-th entry of A								

After sequentially calling `addG(Amy)`, `addG(Ben)`, `addG(Candy)`, `addG(Den)`, `addG(Eda)`, `RemoveG()`, `RemoveG()`, `addG(Eric)`, `addG(Fred)`, `addG(Gail)` and `addG(Hank)`,

`start = 2, next = 1`

i	0	1	2	3	4	5	6	7
the i-th entry of A	Hank		Candy	Den	Eda	Eric	Fred	Gail

(a) (i) The seats of the restaurant are allocated using a first-come-first-served approach. What kind of data structure does `A` belong to?

(ii) Assume that `n = 8`,

`start = 4, next = 1`

i	0	1	2	3	4	5	6	7
the i-th entry of A	Ken				Mike	Belle	Joe	June

Fill in the values below after sequentially calling `addG(Joan)`, `RemoveG()` and `addG(Lily)`.

`start =` [ ] `, next =` [ ]

i	0	1	2	3	4	5	6	7
the i-th entry of A								

(4 marks)

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Please stick the barcode label here.

(b) Complete the pseudocode for `addG(name)` and `RemoveG()` below:

```
addG(name)
    if start = remainder of ((next+1)/n) then
        Exit with the message 'the array is full'
    else
        A[ _____ ] ← name
        next ← _____
    end

RemoveG()
    if next = _____ then
        Exit with the message 'there is no guest'
    else
        start ← remainder of ((start + 1)/n)
        i ← _____
        temp ← A[i]
        A[i] ← empty value
        return temp
end
```

(4 marks)

(c) Mr Chan wants to display the current total number of table reservations in `A`. Write the expression of the current total number of table reservations in each of the following cases:

Case 1: `next >= start` _____

Case 2: `next < start` _____

(3 marks)

Mr Chan uses another array `S` to store the number of seats requested by individual waiting guests. In the following example, Peter requests a table of 8 seats.

`start = 5, next = 3`

i	0	1	2	3	4	5	6	7
the i-th entry of A	Tom	Betty	Ken			Peter	John	Mary

i	0	1	2	3	4	5	6	7
the i-th entry of S	2	4	2			8	4	2

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(d) For any value of n, write a pseudocode to display the current total number of reservations for a table of two seats.

(5 marks)

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3. John develops a colouring method to blacken an image with 4×4 pixels. All pixels of the image are labelled with a number from 1 to 16. Four additional numbers, 17, 18, 19 and 20, are used to represent groups of pixels, pixels 1 to 4, pixels 5 to 8, pixels 9 to 12 and pixels 13 to 16 respectively. For a given image, John will use the shortest sequence of numbers in ascending order to record the pixels to be blackened.

For example, the image below is blackened by '4, 13, 15, 16, 18':

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(a) John's colouring method is applied.

(i) What is the sequence for blackening the following image?

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(ii) Blacken the following image using '1, 5, 6, 19':

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(iii) Blacken the following image using the longest possible sequence:

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(4 marks)

Answers written in the margins will not be marked.

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John plans to write a subprogram with the following variables to restore the image from a sequence.

Variable	Description
A	an integer array for storing the sequence
N	an integer variable for storing the length of the sequence
P	a character array with indexes from 1 to 16 for storing the colours of the pixels ('B' and 'W' represent black and white respectively.)

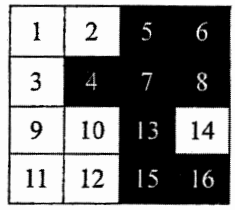
An example is shown below:

The contents of A and N for the image are

i	1	2	3	4	5
the i-th entry of A	4	13	15	16	18

N = 5

The subprogram decodes the data and stores the result in P to represent the image, as shown below:



i	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
the i-th entry of P	W	W	W	B	B	B	B	B	W	W	W	W	B	W	B	B

(b) Assume that the initial content of P is empty. Write the pseudocode for the subprogram.

(5 marks)

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John improves his colouring method by determining the number of times the pixels are referred to by the sequence of numbers. If a pixel is referred to by the sequence once only, it is black; otherwise, the pixel is white. For example, the following image is blackened by '4, 14, 20'. The pixels labelled with the numbers 4, 13, 15 and 16 are referred to once and so they are black. The pixel labelled with the number 14 is referred to twice, by 14 and 20, and so it is white.

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(c) John's improved method is applied.

(i) What is the sequence for blackening the following image?

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(ii) Blacken the following image using '2, 5, 17, 19':

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(3 marks)

(d) Compare John's original method and improved method.

(i) Give an image with 7 black pixels so that the lengths of the sequences produced by the two methods are the same.

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(ii) Give an image in which the difference between the lengths of the sequences produced by the two methods is the largest.

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

(3 marks)

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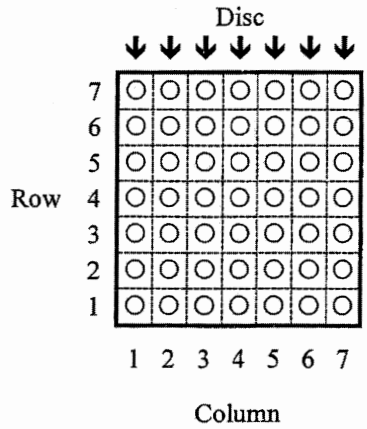
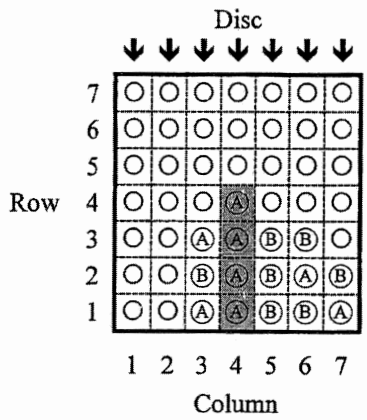
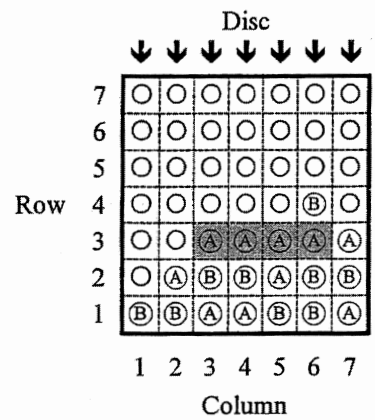
4. Mr Lee plans to write a program for Straight-4 which is a two-player game with a 7×7 game board, shown below. Players will drop one disc each time from the top into a column in turn. The disc will be placed in the lowest unoccupied circle in that column.

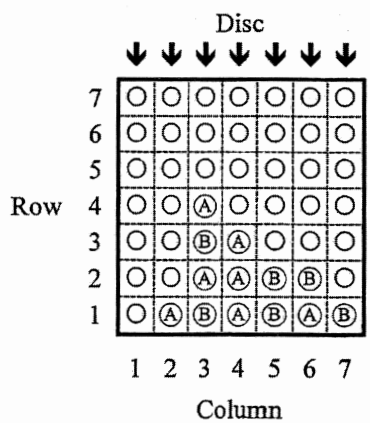


A player wins when he/she has four discs consecutively placed in a row or a column. In the following two examples, the player with disc 'A' wins.





In the pseudocode for the Straight-4 program, Mr Lee uses two global arrays, `BD` and `topC`. An example of the game board and some sample values are shown below:



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Variable	Description	Example	Value
BD	A global two-dimensional, character array for storing the content of the circles on the 7×7 game board (The first and the second indexes represent the column number and the row number respectively.)	BD[2,1] BD[3,1]	A B
topC	A global integer array for storing the row number of the lowest unoccupied circle in that column (The index represents the column number.)	topC[3]	5

Mr Lee writes the following pseudocode for the subprogram `putDisc` to put a disc in the game board.

```
col ← column to be put
player ← player's disc
if (1 ≦ col ≦ 7) and (topC[col] ≦ 7) then
        BD[col, topC[col]] ← player
        topC[col] ← topC[col] + 1
        return true
else
        return false
```

(a) (i) What is the purpose of the condition '`(1 ≦ col ≦ 7)`' in the *if* statement?

(ii) What is the purpose of the condition '`(topC[col] ≦ 7)`' in the *if* statement?

(iii) What should the Straight-4 program do next if the return value of `putDisc` is `false`?

(3 marks)

Answers written in the margins will not be marked.

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Mr Lee uses the subprograms `checkCol` and `checkRow` to check if four discs of a single player are consecutively placed in a column and a row respectively. The checking will be done after `putDisc` is executed. They will return `true` if the player wins, or `false` otherwise. Other than `BD` and `topC`, Mr Lee uses the following variables in the subprograms:

Variable	Description
`col`	an integer variable for storing the column number in which a disc has just been put
`player`	an character variable for storing the disc label that indicates the player's identity
`connected`	an integer variable for counting the number of discs connected during checking
`i`	a temporary integer variable

(b) Complete the following pseudocode for `checkCol`.

```
col ← the column number in which a disc has just been put
player ← player's disc
connected ← 1

i ← topC[          ] - 2

while (i ≧ 1) and (BD[          ,          ] = player) do
      connected ← connected + 1
      i ← i - 1

if (connected =          )
then return true
else return false
```

(4 marks)

Answers written in the margins will not be marked.

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(c) Write `checkRow` in Pascal, C, Visual Basic or Java. The first lines are given below. You can directly use the variables used in Parts (a) and (b) and define other variables if necessary. For the C version, `checkRow` returns 1 and 0 to represent the Boolean values 'true' and 'false' respectively.

Pascal version	`Function checkRow(col:integer; player:char):boolean`
C version	`int checkRow(int col, char player)`
Visual Basic version	`Function checkRow(col As Integer, player As char) As Boolean`
Java version	`boolean checkRow(int col, char player)`

(7 marks)

END OF PAPER

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