CANDIDATE NAME	
CG		INDEX NO	

COMPUTING **9569/01**

Paper 1 Written **14 Sep 2021**
3 hours

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class clearly on the cover page.

Write in dark blue or black pen on the writing paper provided.
You may use an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
Approved calculators are allowed.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is **100**

1 An iterative function `Fn` has two parameters, `Arr` and `Object`, and returns an integer. The pseudocode is as follows:

```
01 FUNCTION Fn(Arr: ARRAY, Object: STRING) RETURNS INTEGER
02    Current ← 1
03    REPEAT
04      IF Object = Arr[Current]
05        THEN
06           RETURN Current
07      ENDIF
08      IF Object > Arr[Current]
09        THEN
10           Next ← 1 + Current * 2
11        ELSE
12           Next ← Current * 2
13      ENDIF
14      Current ← Next
15    UNTIL Current > LENGTH(Arr)
16    RETURN -1
17 ENDFUNCTION
```

A binary search tree is used to store the names of the 12 Chinese Zodiac animals. The order in which these names were added into the tree follows the order in the array `X`.

Array X

X[1]	'Rat'	X[7]	'Tiger'
X[2]	'Monkey'	X[8]	'Dog'
X[3]	'Snake'	X[9]	'Horse'
X[4]	'Dragon'	X[10]	'Ox'
X[5]	'Pig'	X[11]	'Rabbit'
X[6]	'Sheep'	X[12]	'Rooster'

(a) Draw the binary tree using the array X. [3]

(b) Complete the trace table templates provided for the following function calls and state the RETURN value after each function call:

Current	Object = Arr[Current]	Object > Arr[Current]	Next
Output :			

(i) Function call: `Fn(X,'Sheep')` [2]

(ii) Function call: `Fn(X,'Duck')` [3]

(c) Describe the purpose of function `Fn`. [2]

(d) Explain why this function `Fn` is more efficient than linear search. [2]

(e) It is found that one of the Zodiac animals should be named as 'Goat' instead of 'Sheep'. Design another array Y such that the function `Fn` can be used with the correct list of the Chinese Zodiac animals.

Complete the template provided for the array Y. [2]

3

[Turn over

2 A merge sort algorithm consists of the function `merge_sort(seq)` that takes in an unsorted list `seq` as an input and returns a sorted list. The function uses the helper function `merge(left,right)` which merges the two sorted lists, `left` and `right`, and returns a sorted list.

The following is the pseudocode for the function `merge(left,right)`:

```
01  FUNCTION merge(left: LIST, right: LIST) RETURNS LIST
02    IF LENGTH(left) = 0
03      THEN
04        RETURN right
05      ELSE
06        IF LENGTH(right) = 0
07          THEN
08            RETURN left
09        ENDIF
10    ENDIF
11    IF left[0] < right[0]
12      THEN
13        RETURN [left[0]] + merge(left[1:], right)
14      ELSE
15        RETURN [right[0]] + merge(left, right[1:])
16    ENDIF
```

(a) Explain why this is a recursive function. [2]

(b) State whether this `merge` implementation is stable or unstable and explain with an example. [2]

(c) Complete the merge sort algorithm by writing the pseudocode for the function `merge_sort(seq)`. [4]

(d) State **one** advantage and **one** disadvantage of a merge sort algorithm over a bubble sort algorithm. [2]

4

(e) Explain whether using a merge sort algorithm or a bubble sort algorithm will be more efficient in arranging the data list `[2,1,3,4,6,5,8,7,9,10,12,11]` in an ascending order. [3]

3 A stack is a last-in-first-out (LIFO) abstract data type (ADT) in which all the elements are inserted and removed from one end.

It is common to either use a linked list or an array to implement a stack.
- In the linked list implementation, a root pointer points to the top of a stack and a data structure. The data structure contains the value of the data and a pointer pointing to the next node in the stack.
- In the array implementation, a fixed size array is used to store the elements.

The basic stack operations of `push()`, `pop()` and `peek()` are provided in both implementations.
- `push()` is used to insert an element into the stack.
- `pop()` removes an element from the stack and returns the value of the element.
- `peek()` returns the value of the element at the top of the stack without removing it.

(a) Describe what an abstract data type is and how it benefits the user. [3]

(b) State **one** advantage and **one** disadvantage of implementing the stack ADT using a linked list. [2]

(c) State **one** advantage and **one** disadvantage of implementing the stack ADT using an array. [2]

(d) Describe how a `push()` operation is done in a stack ADT which is implemented using a linked list. [3]

(e) Describe how the number of elements within a stack can be counted using only the basic stack operations provided. [3]

5

The following program code uses a Python list as an array with the built-in functions `<list>.insert()` and `<list>.pop()`.

```
01  def add(seq):
02      stk = []
03      def InsertOne(item):
04          if stk==[] or item < stk[0]:
05              stk.insert(0,item)
06          else:
07              temp = stk.pop(0)
08              InsertOne(item)
09              stk.insert(0,temp)
10      for ele in seq:
11          InsertOne(ele)
12      return stk
```

(f) **(i)** The above is an example of implementing a stack using an array.

State and explain how the program code adds all the elements in the sequence `seq` into the stack. [2]

(ii) Modify the above program code such that it uses only the basic stack ADT operations provided. [4]

6

4   The following shows a sample of a student's result slip for the Preliminary Examination.

AUDE EXAURARE JUNIOR COLLEGE			
2021 JC2 Preliminary Examination			
Name:	TAN XIAO MING		
Identification No.:	T0312321E		
Civics Group:	20S23		
Index No.:	18		
Subject	**Code**	**Mark**	**Grade**
H1 General Paper	8807	55	C
H1 Economics	8823	51	D
H2 Mathematics	9758	66	B
H2 Physics	9749	62	B
H2 Computing	9569	78	A

The college wishes to manage this result information using a relational database. The normalised database design requires to have a number of tables.

(a) Draw an Entity-Relationship (E-R) diagram showing these tables and the relationships between them. [4]

(b) A table description can be expressed as:

```
TableName (Attribute1, Attribute2, Attribute3, …)
```

The primary key is indicated by underlining one or more attributes. Foreign keys are indicated by using a dashed underline.

Write table descriptions for the tables you identified in **part (a)**. [5]

(c) Under the Personal Data Protection Act (PDPA), the NRIC/FIN can no longer be used as a unique identifier for each student. Suggest and justify a suitable alternative unique identifier for each student. [2]

(d) Write an SQL query to output the names, civics groups and grades of students who have obtained at least 60 marks for H2 Computing. [4]

5 The Food Services Industry Digital Plan (IDP) was recently launched by the Minister of State for Trade and Industry to help F&B businesses adopt more digital technologies in their daily operations.

The manager of a local restaurant engaged a consultant to propose a digital solution for his restaurant operations. After conducting a comprehensive study, the consultant proposed a web-based solution using a client-server model.

The solution requires the following hardware to access the web server wirelessly in the local area network (LAN):

- A tablet device on each table for customers to browse the menu and order their food items.
- Multiple large monitors for the chefs in the kitchen to read the ordered food items.
- A computer station for the service staff to check the table number before serving the food to the customers.
- A computer in the manager's office to update the menu in the web server and print the daily sales report.

When a customer decides to pay the bill, a QR code will be generated on the tablet device for him to scan and make online payment using his personal mobile device.

(a) Explain the meaning of the term client-server model. [1]

(b) Describe the main software components to be developed for the web server to host this service for the restaurant. [2]

(c) Describe how the customer would use the client tablet device to browse and order the food items. [3]

(d) Suggest **one** feature on the digital form that will provide a positive experience for the customers when using the tablet device to order their food. Describe the usability principle applied in this feature. [2]

9

(e) The manager recommends the proposed solution to the shareholders, but a number of social issues associated with the solution have been raised. Describe **two** possible issues that could have been raised. [2]

An alternative to this web-based solution would be to develop a native application programme for the customers to download and install on their mobile devices.

(f) Describe **one** feature that is only available in the native application solution and how it is relevant to the solution proposed for the restaurant. [2]

The restaurant's manager is also keen to expand his business to accept online ordering for takeaways.

(g) Explain **one** benefit of the web-based solution in this situation. [1]

(h) Draw the network diagram for the proposed web-based solution and include all the required hardware for the restaurant to accept online ordering. [5]

(i) Describe **two** benefits for the restaurant in implementing this solution. [2]

(j) For online ordering, the restaurant needs to collect the customer's name, address and contact number. State and describe **two** data protection obligations that the manager needs to comply under the Personal Data Protection Act. [4]

6 A fantasy card game was developed using object-oriented programming (OOP) to store its cards' data. A card can either be a minion or a weapon. Each card has a name, mana cost, health or durability and attack power.

In order to play a card, a player must spend a certain amount of mana as specified in the card's mana cost. When the card has been played, the player may decide whether to use it to attack another minion or not.

A minion may belong to one of the following races: beast, demon, dragon or elemental. When a minion is attacked, its health would decrease according to the attacking card's attack power. Once the health of a minion decreases to zero, it is destroyed and removed from the game.

Instead of health, a weapon has durability and it cannot be attacked. When a weapon is used for an attack, its durability would decrease by one. Once the durability of a weapon decreases to zero, it is destroyed and removed from the game.

(a) Draw a class diagram, showing:
- the base class CARD,
- any sub-classes and inheritance from the base class,
- the properties for the base class and sub-classes,
- appropriate methods with at least one getter and one setter method. [7]

(b) In relation to your diagram in part **(a)**, explain the terms:
- **(i)** encapsulation,
- **(ii)** inheritance,
- **(iii)** polymorphism. [6]

(c) Explain why OOP is a preferred programming paradigm in the development of this game. [2]

[Turn over

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Trace Table Templates for Question 1(b):

(i)   Function call: `Fn(X,'Sheep')`

Current	Object = Arr[Current]	Object > Arr[Current]	Next
Output :			

(ii)   Function call: `Fn(X,'Duck')`

Current	Object = Arr[Current]	Object > Arr[Current]	Next
Output :			

Template for Question 1(e):

Array Y

Y[1]		Y[7]	
Y[2]		Y[8]	
Y[3]		Y[9]	
Y[4]		Y[10]	
Y[5]		Y[11]	
Y[6]		Y[12]	

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