

2022 JC 2 H2 Computing Mock Practice 2 (Paper 1)

- 1 A linear queue data structure is implemented as an array of fixed length `Limit` with subscript starting from 0 to `N-1`. The number of data items currently stored in the linear queue is maintained by `Size`, while `Front` and `Rear` are used as pointers to the first and the last data items held in the queue respectively.
- (a) State the `Front` and `Rear` values of a newly initialised empty linear queue. [2]
- (b) With the aid of a diagram, explain how a new data item can be
- (i) added into the linear queue. [4]
- (ii) removed from the linear queue. [4]
- (c) Describe a potential limitation that may arise in this queue implementation. [1]
- (d) Without changing `Size`, `Limit`, `Front`, and `Rear`, write the algorithms to add and remove from the queue such that the issue mentioned in (c) is eliminated. [4]
- (e) State **two** real-life applications of using queues. [2]
- 2 Define and explain the following terms used in the Object-Oriented Programming (OOP).
- (a) Encapsulation [2]
- (b) Inheritance [2]
- (c) Data hiding [2]
- (d) Polymorphism [2]
- 3 In computer science, recursion is a way of problem solving where the solution depends on smaller instances of the solution for the same problem.
- (a) What is recursion and how is it different from iteration? [3]

The algorithm given below describes a method of finding a composer's name in an array of `N` unique names `NAMES`.

```

01 FUNCTION find(NAMES : ARRAY, cname : STRING) RETURNS BOOLEAN
02     first <-- 1
03     last <-- len(NAMES) // len returns size of array
04     REPEAT
05         mid <-- (first + last) DIV 2 //DIV returns integer division
06         IF NAMES[mid] = cname THEN
07             return TRUE
08         ENDIF
09         IF NAMES[mid] < cname THEN
10             first <-- mid + 1
11         ELSE
12             last <-- mid - 1
13         ENDIF
14     UNTIL first > last
15     RETURN FALSE
16 ENDFUNCTION

```

(b) What is the search function `find`? State the condition for it to work properly. [2]

Given that `NAMES = ['Bach', 'Bartok', 'Dvorak', 'Handel', 'Liszt', 'Prokofiev', 'Shostakovich', 'Vivaldi']`.

(c) List the names in the order they have been examined when `find` is used to search the composer with names `'Vivaldi'`.

(i) `'Vivaldi'`, [2]

(ii) `'A. Corelli'`. [2]

(d) The array `NAMES` was updated and now it contains 678 composer names.

(i) State the worst case time complexity for the search function `find`. [1]

(ii) Find the maximum number of names examined by the search function `find` when an unsuccessful search was performed. [2]

4 The insertion sort is used to sort the following list of numbers:

35, 57, 19, 59, 48, 89, 30

(a) Explain with the aid of diagram(s), how insertion sort orders the list of numbers in ascending order. [6]

(b) State **two** factors a programmer should consider before using insertion sort. [2]

(c) Describe a scenario where the time complexity of insertion sort is $O(n^2)$. [2]

- 5 Students from ABC Junior College are currently required to enter and submit a hardcopy loan record form if they would like to borrow a computing device from the school. A sample loan record form is shown below.

Laptop Loan Request Form				
Loan ID:	JPJC0001	Date of Borrow:	29/04/2021	
Identity Card No:	T1234567A	Date of Return:	10/05/2021	
Student Name:	Charles Sng	Due Date:	13/05/2021	
Class ID:	7	Contact No:	99876543	
Civics Tutor:	Ms. Oh Tah Koo			
Device(s) Loaned:				
Serial No.	Type	Brand Name	Model	Remarks
L0011323A	Laptop	Venolo	ThinkLad	No USB-C port.
M0011193C	Mouse	Laser	ClickingPro	Nil

The college has engaged an IT solutions company to computerise the existing hardcopy loan records system into a digital loan system with a relational database management system (RDBMS).

- (a) State **three** advantages of using a RDBMS over the current system. [3]
- (b) Explain why data sensitivity could be a potential concern and it could be resolved. [3]
- (c) Define primary key in the context of a relational database. [2]

A relational database is used to store the information of the loan transactions. When a loan is performed, a new loan transaction will be created and recorded in the database. It is also given that:

- A student is uniquely identified by his/her identity card number.
- Every device is tagged with a unique serial number.
- There are a total of 10 classes, each uniquely represented by a distinct integer value between 1 and 10.
- One class is assigned exactly one civics tutor.
- A student can only belong to one civics class.

A table description can be expressed as:

Tablename(Attribute1, Attribute2, Attribute3,...)

The primary key is indicated by underlining one or more attributes.

- (d) What is normalisation? [2]

- (e) Draw an Entity-Relationship (E-R) diagram for the fully normalised database of the digital loan system. [3]
- (f) Write the table descriptions of the database in (e). [4]

After the digital loan system was developed and implemented, end-user training have to be arranged for school clerks who hold little to no experience in using a computerised information management system..

- (g) With the use of an example in each case, how would you explain the process of data verification and data validation to these clerks in training? [4]

6 A hospital carpark management team wants to implement a Carpark Tracking System to keep track of the vehicle details and the total number of vehicles that enters its compound. Every vehicle is installed with an In-Vehicle Unit (IU) that can be used to identify each vehicle uniquely. The IU reader installed at the carpark entrance barrier can capture and record the 10-digit IU number of any vehicle that passes through.

- (a) Apart from the IU number captured by the reader, give **two** other relevant data that need to be stored as well. [2]

The captured vehicle entry records will be stored in a hash table using the 10-digit IU number as the key.

- (b) What is a hash function? [1]
- (c) Given that the hash table was implemented as an array of records with index starting from 0 to 562, describe the operation to insert vehicle entry record with IU number 1125795021 into the hash table using the hash function in (b), assuming that the hash table was empty before the insertion. [3]
- (d) Explain how collisions happen. [1]
- (e) Describe how linear probing can be used to handle collisions. [2]
- (f) Linear probing subjected to clustering. What is clustering, and why it is an issue? [2]

- 7 (a) What is a binary search tree? [2]

The table below shows an array representation of a binary search tree T that has been initialised to empty state, and implemented using a fixed sized linear array of `TreeNode`s.

Location	Left	Data	Right	
6	0	Null	0	Head = x
5	6	Null	0	Free = 1
4	5	Null	0	
3	4	Null	0	
2	3	Null	0	
1	2	Null	0	

- (b) State the value of x . [1]

The following pseudocode was run in the order as shown below:

```

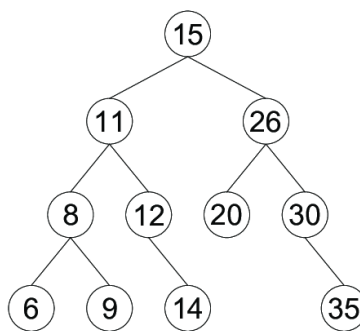
01 T = BST() // instantiates an object of class binary search tree
02 T.insert("Nigel") //inserts TreeNode with Data="Nigel" into T
03 T.insert("Ken")
04 T.insert("Vincent")
05 T.insert("Albert")
06 T.insert("Clarence")
07 T.insert("Colin")

```

- (c) Update the values of the table given in (b). [3]

- (d) Draw the tree diagram of binary search tree T based using the updated table values obtained in (c). [3]

- 8 Traversal was performed on the binary tree shown below.



- (a) List the nodes in the order that they are visited for
- (i) in-order traversal, [1]
 - (ii) pre-order traversal, [2]
 - (iii) post-order traversal. [2]
- (b) Express the infix expression $8 / (9 - 5) + 2 * 4$ to postfix. [2]

- 9 **(a)** What are the characteristics of client-server network architecture? [2]
- (b)** Name 2 different types of servers, and briefly describe how they work. [3]

END OF PAPER