YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME	
CG	INDEX NO

COMPUTING **9569/01**

Paper 1 Written **14 Sep 2022**

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**

This document consists of **11** printed pages and **1** blank page.

1 A 1D array, `arr`, stores a list of scores as follows:

Index	1	2	3	4	5	6	7	8	9	10	11
arr	3	12	13	17	21	24	26	33	37	41	42

(a) Using a linear search, state the number of comparisons required to find the score of `33`. [1]

The function `Fn` is a binary search algorithm that performs a search for the value `key`, in the array of scores, `arr`, and returns an integer value.

```
01 FUNCTION Fn(arr: ARRAY, key: INTEGER) RETURNS INTEGER
02    Low ← 1
03    High ← ArraySize
04    REPEAT
05       Mid ← INT((Low + High)/2)
06       IF arr[Mid] = key
07          THEN
08             RETURN Mid
09          ELSE
10             IF arr[Mid] < key
11                THEN
12                   _____ ← _____
13                ELSE
14                   _____ ← _____
15             ENDIF
16       ENDIF
17    UNTIL Low > High
18    RETURN -1
19 ENDFUNCTION
```

(b) Complete the missing pseudocode for lines 12 and 14. [2]

(c) Function `Fn` can return **two** different types of value.
Explain what these represent. [2]

(d) Copy and complete the trace table for the execution of the function call `OUTPUT Fn(arr, 33)`.

key	Low	High	Mid	arr[Mid]	OUTPUT
33					

(You may add additional rows if required.) [4]

(e) Describe how hashing the scores and storing them in a hash table of size 11 could improve the performance in searching for a score value. [4]

2 The procedure `P` calls on the recursive function `Q` to sort the contents of an array `arr`.

For an array `X` with the contents sorted from index `1` to `k-1`, executing the function `Q(X,k)` will shift the element at the index `k` into a correct position such that the array is sorted from index `1` to `k`.

```
01 PROCEDURE P(arr: ARRAY)
02    FOR j ← 2 TO ArraySize
03        Q(arr, j)
04    ENDFOR
05 ENDPROCEDURE

06 FUNCTION Q(arr: ARRAY, i: INTEGER)
07    IF arr[i-1] < arr[i]:
08        RETURN
09    ELSE
10        Temp = arr[i]
11        arr[i] = arr[i-1]
12        arr[i-1] = Temp
13        Q(arr, i-1)
14    ENDIF
15 ENDFUNCTION
```

(a) Identify where and why the function `Q` is a recursive function.   [2]

(b) Using the procedure `P` to sort an array will result in an error. Describe the error and explain the change required to correct this error.   [3]

(c) Name the type of error identified in your answer to **part (b)**.   [1]

The data in the following array `H` are stored in a Binary Search Tree (BST).

Index	1	2	3	4	5	6	7	8	9
H	167	159	125	172	141	124	178	130	163

(d) Draw the binary tree for the array `H` dataset.   [3]

(e) Describe how the BST could be used to sort the content in the array `H`. State the disadvantage of using such a method to produce a sorted array.   [3]

3 A ticketing company, *FastTickets*, intends to implement an online queue system to control the number of customers accessing the ticket purchasing page simultaneously.

When customers access the website, they will be placed in an online queue while waiting for the system to grant them access to the ticket purchase webpage. The customers can decide to leave the queue anytime if they choose not to wait for their turn. This will help to ensure smooth transactions, improve the users' experience and prevent the web server from overloading during peak seasons.

(a) The programmer considers two options: an array and a linked list.

(i) Give **two** advantages of using a linked list to implement the queue system.

[2]

(ii) Give **one** disadvantage of using a linked list to implement the queue system. [1]

FastTickets decides to use Object-Oriented Programming (OOP) to implement the linked list data structure for the online queue system.

The class `LinkedList` will store the following data:
- A linked list of the data nodes
- A start pointer `StartPtr`

Each node is implemented as an instance of the class `DataNode` with the following two properties:
- The node data `DataValue` contains the customer's ID `CustID`.
- The node pointer `Ptr` points to the next node in the linked list.

When a customer joins the queue, a node is created using the customer's ID `CustID` and the node pointer `Ptr` is set to `None`.

(b) Draw a UML diagram for the class `DataNode`, showing the properties and the methods to construct a node, to access and modify the properties. [4]

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The linked list is implemented as an instance of the class `LinkedList`. The class `LinkedList` has the following properties and methods:

Class: `LinkedList`
`StartPtr: DataNode` object   (Default set to `None` for an empty linked list.)

`constructor`
 `enqueue(CustID: STRING)`
 `dequeue(): STRING`
 `remove(CustID: STRING)`
 `get_position(CustID: STRING): INTEGER`
 `is_empty(): BOOLEAN`

The method `remove(CustID)` is used to remove the `DataNode` from the linked list when a customer decides to leave the queue. The method `get_position(CustID)` returns an integer indicating the number of customers in front of a particular customer with `CustID`.

(c)   Describe the algorithms for the following methods:

   (i)   `enqueue(CustID)` to add a new `DataNode` into the linked list when a customer with `CustID` joins the online queue.   [4]

   (ii)   `get_position(CustID)` to return the number of customers in front of a particular customer with `CustID` in the queue.   [4]

All customer IDs start with a letter followed by an integer. The starting letter `'V'` is for VIP customers and `'C'` is for normal customers. For example, `'V2435'` and `'C120067'`.
When a VIP customer joins the online queue, he will be inserted in front of all the normal customers but behind the VIP customers who are already in the queue.

(d)   Write pseudocode for the additional method `enqueue_VIP(CustID)` that inserts the node in the correct position within the linked list when a VIP customer `CustID` joins the queue.   [5]

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4 An arcade game centre uses a game card system for their game machines. Each game card has a unique identification ID. The customer inserts the game card into a machine to start the game and the cost will be deducted from the card balance. When the card balance is low, the customer can top up the game card in multiples of $50 using any online banking application.

When the customer wins a particular game, reward tickets will be issued and credited into the game card. The accumulated reward tickets could be used to redeem gifts.

The table shows the typical data recorded for all the transactions.

Card ID	Cust NRIC	Cust HP	Game ID	Game Station	Cost per Game	Date	Time	Ticket Issued
21215	697A	98765431	8888	"Top Up"	50.00	120822	1146	0
21215	697A	98765431	1650	"Fish Pond"	-2.20	120822	1200	55
21215	697A	98765431	2551	"Moon Racer"	-3.50	120822	1226	20
21215	697A	98765431	2551	"Moon Racer"	-3.50	120822	1230	25
71121	112K	88135423	8888	"Top Up"	50.00	120822	1230	0
71121	112K	88135423	1650	"Fish Pond"	-2.20	120822	1252	58
21215	697A	98765431	2551	"Moon Racer"	-3.50	120822	1252	22
71121	112K	88135423	1650	"Fish Pond"	-2.20	120822	1257	60
12345	312H	86212123	8888	"Top Up"	50.00	130822	1146	0
21215	697A	98765431	1650	"Fish Pond"	-2.20	130822	1302	52
12345	312H	86212123	4112	"Dance Now"	-3.80	130822	1315	34

(a) Explain whether the above table is in first normal form (1NF). [2]

The manager wants to construct a relational database to reduce data redundancy.

The following tables contain the data:

Card

Card ID	Cust NRIC	Cust HP
21215	697A	98765431
71121	112K	88135423
12345	312H	86212123

Game

Game ID	Game Station
2551	"Moon Racer"
1650	"Fish Pond"
4112	"Dance Now"
8888	"Top Up"

UsedOn

Card ID	Game ID	Cost per Game	Date	Start Time	Ticket Issued
21215	8888	50.00	120822	1146	0
21215	1650	-2.20	120822	1200	55
21215	2551	-3.50	120822	1226	20
21215	2551	-3.50	120822	1230	25
71121	8888	50.00	120822	1230	0
71121	1650	-2.20	120822	1252	58
21215	2551	-3.50	120822	1252	22
71121	1650	-2.20	120822	1257	60
12345	8888	50.00	130822	1018	0
21215	1650	-2.20	130822	1302	52
12345	4112	-3.80	130822	1315	34

(b) Draw an entity-relationship (ER) diagram showing the relationships between the three tables. [3]

(c) 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 using a dashed underline.

Write table descriptions for the above three tables. [3]

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(d) Explain why the table UsedOn is not in second normal form (2NF) and how the tables should be modified to fulfil the requirement. [3]

(e) Explain if all tables are in third normal form (3NF) after the modification done in **part (d)**. [2]

(f) Describe an algorithm to compute the card balance for the card with CardID=21215. [2]

(g) Write an SQL query to output the Game Station name and the total number of tickets issued to the customers playing the game with GameID=2551. [5]

5 A hospital keeps all the patients' details and records in a database server within the local area network (LAN). The patients can access the web server via the internet to check on their medical appointments.

(a) Explain two ways to prevent unauthorised access to the data in the network. [2]

(b) Describe two possible ways in which the data stored in the database servers could be lost. [2]

(c) Describe two backup strategies which could be effective in protecting against data loss. [2]

(d) Explain how HTTPS protocol protects the data transmission when the patients access the web server to check on their appointments. [2]

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6 Both hashing and encryption convert the original plaintext data into encoded information unreadable by any human or computer without decoding it.

(a) Describe one example of how a hashing algorithm, like MD-5 and SHA-256, could be used to verify or validate the original data. [2]

(b) Describe how asymmetric encryption is being used when a sender sends a sensitive email such that only the receiver can decrypt the message. [2]

(c) Describe how asymmetric encryption could be used to authenticate the sender's identity when he sends a message to the receiver. [2]

7 The distributed Denial-of-Service (DDoS) is one of the cybersecurity threats that could disrupt a company's business and cause significant financial loss in its online operation.

(a) Describe how a DDoS attack is being set up against a company. [2]

(b) State and explain two strategies to prevent a DDoS attack from causing business disruption. [4]

8 The smart webcam manufactured by the local company *EyesOnYou* (EOY) is very popular among office owners as a security camera and home users as a home or baby monitor solution. They can be easily installed with an existing local area network (LAN). The video footage will be transmitted to the EOY's data centre and the users can either watch the live stream or download the video footage over the internet.

EOY has appointed a Data Protection Officer (DPO) to establish the standard operation procedure (SOP) to ensure compliance with the Personal Data Protection Act (PDPA).

(a) State and explain two of the key obligations under PDPA. Give a relevant example in the context of EOY how each of these obligations can be met. [4]

EOY intends to hire and train 100 part-time technicians to help with the installation of the webcam at the customers' site. They will configure the webcam to connect to the customers' LAN and set up new accounts for them to access the video footage from the data centre.

(b) In the course of the work, these part-time technicians may have access to the customers' and EOY's classified information. The DPO is required to draft the Code of Conduct for the management to include in the employment contracts.

    (i) Suggest two rules to be included in the Code of Conduct. Explain what unethical behaviour(s) each of these rules hopes to prevent. [4]

    (ii) It is possible that out of convenience, a technician may use the same generic password to set up new accounts for different customers. Suggest two ways to prevent any unauthorised access to the customers' account and their video footages. [2]

A webcam user, John, found a security vulnerability in the EOY's network at the data centre which allows a legitimate user to access the video footages from other users. He reported the vulnerability to EOY's Customer Service Department but there was no response from the company even after waiting for 90 days. John eventually lodged a complaint to the Personal Data Protection Commission (PDPC).

During the investigation by the PDPC, it was found that the staff in the Customer Service Department have been using a common login password so that any other staff could still access the computer system even when a colleague is away from the office.

(c) Suggest what should be done when the Customer Service Department receives any vulnerability report from the public. [2]

(d) Explain how the use of a common login password compromises the confidentiality of personal data under the PDPA. [1]

(e) Suggest two new operations to be included in the SOP to prevent the use of common login password in future. [2]

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