



YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE
NAME

CG

INDEX NO

COMPUTING

Paper 1 Written

9569/01

13 Sep 2022

3 hours

Additional Materials:

Answer Sheet

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 A digital handheld device is used to scan vehicle numbers and the data will be sent to the server using a six-bit binary encoding method. The characters in the data, comprising numbers from 0 to 9 and letters A to Z, are represented by the binary numbers as shown in the following table:

Character	Denary Number	Binary Number
'0'	0	000000
'1'	1	000001
'2'	2	000010
'3'	3	000011
'4'	4	000100
'5'	5	000101
'6'	6	000110
'7'	7	000111
'8'	8	001000
'9'	9	001001
'A'	10	001010
to	to	to
'Z'	35	100011

- (a) State the number of other characters that can be represented besides 0 to 9 and A to Z using the six-bit binary encoding method. [1]

$$2^6 - 36 = 64 - 36 = 28$$

- (b) Explain the benefit of using this six-bit binary encoding method to represent 0 to 9 and A to Z. [2]

[1] Lesser number of bits required for [1] transmission and storage.

- (c) Express the number representing the letter 'X' as:

- (i) a six-bit binary number [1]

'X' is represented by 33 in denary, hence 100 001 in binary.

- (ii) a hexadecimal number [1]

33 in denary = 0010 0001 in binary = 21 in hexadecimal

A Media Access Control (MAC) address is a twelve-digit hexadecimal number assigned to each device connected to the network.

An example of a MAC address is as follows:

3A-34-52-C4-69-B8

- (d) Give two reasons why hexadecimal numbers are used in computing. [2]

Any of the following 2:

1. Hexadecimal numbers can be converted to and from binary numbers, each hexadecimal digit corresponds to four binary bits.
2. Hexadecimal number is easier to read as compared to a long binary number.
3. Hexadecimal numbers is a more compact representation, each hexadecimal digit can represent 16 different values, hence it can represent the same amount of data with fewer digits.

- (e) Convert the above MAC address to:

- (i) a 48-bit binary number [2]

Convert each hex digit to 4 binary digits:

= 3 A 3 4 5 2 C 4 6 9 B 8
= 0011 1010 0011 0100 0101 0010 1100 0100 0110 1001 1011 1000

- (ii) an octal number [2]

Convert each hex digit to 4 binary digits and then convert each 3 binary digits to octal digits:

= 3 A 3 4 5 2 C 4 6 9 B 8
= 0011 1010 0011 0100 0101 0010 1100 0100 0110 1001 1011 1000
= 1 110 100 011 010 001 010 010 110 001 000 110 100 110 111 000
= 1 6 4 3 2 1 2 2 6 1 0 6 4 6 7 0

- 2 A large online store has a team of Customer Service Officers (CSO) to assist customers regarding their online purchases over the phone. When a customer calls, the CSO can use the phone number appearing on a Caller-ID device to retrieve the customer's details from the store's database.

Since the customer's registered phone number is unique, it can be used as a primary key to retrieve the customer's data.

The programmer can either use a sorted array or a hash table to store and retrieve customers' data.

~~(a) Describe the process of storing customers' data in an array and performing a binary search to retrieve a customer's data using the registered phone number.~~

The customers' data is sorted according to the registered phone number and stored in an array.

Describe the binary search process in retrieving a customer's data using the registered phone number.

[4]

[1] Calculate the index, mid, of the middle element in a sorted array. Check if the middle element is the required data; if yes, retrieve the customer's data.

[1] If the middle element is greater than the required data, then narrow the search to the left segment of the array from start index to (mid-1) index.

[1] If the middle element is smaller than the required data, then narrow the search to the right segment of the array from (mid+1) index to the last index.

[1] Repeat the previous 3 steps until the required data is found or when the segment to search has no element or only one element which is not the required data.

(b) (i) Give **one** disadvantage of using an array to store customers' data sorted by the phone numbers. [1]

Any one of the following:

- Whenever a new data is added into the array, all the data need to be sorted again.

- When a customer changes phone number, the updated array will need to be sorted.

- (ii) Give **two** advantages of using a hash table to store customers' data. [2]
- [1] Can retrieve the customer's data quickly $O(1)$ by using the key identifier (ie the hashed value of the phone number.)
- [1] New data can be added without reorganising the existing data.

A hash table of size 10 is used to store the following customers' data according to the order in which the online purchases are made.

Order Number	Customer Name	Phone Number
62423	Aileen Goh	84621039
72525	Benjamin Teo	85269413
73536	Charlie Lee	96348217
74511	Damian Wong	84903216
83472	Elsa Ng	83209547
93642	Fatimah Siti	89321065
96262	Gerald Lim	82345917

The hash value for the phone number 84621039 can be found using the following algorithm:

$$\begin{aligned}
 \text{hash}('84621039') &= (8 + 4 + 6 + 2 + 1 + 0 + 3 + 9) \% 10 \\
 &= 33 \% 10 \\
 &= 3
 \end{aligned}$$

The hash value for the phone number will be used as the index position to store the customer's data in the hash table.

All collisions are resolved using the Linear Probing (Closed Hashing) technique.

- (c) The customer's data for Aileen Goh has been inserted into the hash table for your reference.

Complete the following hash table in the Answer Sheet.

[3]

Index	Hash Value	Customer's Data (Order Number, Name, Phone Number)
0	0	73536, Charlie Lee, 96348217
1	9	96262, Gerald Lim, 82345917
2		
3	3	62423, Aileen Goh, 84621039
4	3	74511, Damian Wong, 84903216
5	4	93642, Fatimah Siti, 89321065
6		
7		
8	8	72525, Benjamin Teo, 85269413
9	8	83472, Elsa Ng, 83209547

- (d) The programmer uses a searching algorithm to retrieve customers' data from the hash table completed in **part (c)**. It prints the customer's data if found; Otherwise, it prints 'Customer data not found'.

Explain the process in which the algorithm searches for the following phone numbers:

- (i) 89321065 [1]

Hash(89321065)=4, check index 3 which is not 89321065, go to index 4 and found 89321065, hence Found.

- (ii) 87951032 [1]

Hash(87951032)=5, check index 5 which is not 87951032, go to index 6 and found that it is empty, hence Not Found.

- (iii) 90381485 [1]

Hash(90381485)=8, check index 8 which is not 90381485, go to index 9, 0, 1 which are not 90381485, go to index 2 and found that it is empty, hence Not Found.

- 3 An airline sells both Business Class and Economy Class tickets. The customers buying the tickets are either members or non-members of the airline. All members are eligible for a 10% discount. Members will be given **an additional** 10% discount for the off-peak Business Class tickets. Non-members will only receive 10% discount for the off-peak Business Class tickets.

- (a) Create a decision table showing all the possible conditions and actions. [4]

Conditions			Actions		
Member	Season	Ticket	20% disc	10% disc	No discount
Y	Off-Peak	Business	✓		
Y	Off-Peak	Economy		✓	
Y	Peak	Business		✓	
Y	Peak	Economy		✓	
N	Off-Peak	Business		✓	
N	Off-Peak	Economy			✓
N	Peak	Business			✓
N	Peak	Economy			✓

- (b) Simplify your decision table by removing redundancies. [4]

Conditions			Actions		
Member	Season	Ticket	20% disc	10% disc	No discount
Y	Off-Peak	Business	✓		
Y	-	Economy		✓	
Y	Peak	-		✓	
N	Off-Peak	Business		✓	
N	-	Economy			✓
N	Peak	-			✓

- (c) With reference to your answer in **part (b)**, write a function using pseudocode. The function will prompt the customer to indicate the membership, the type of flight ticket and the travelling period (Peak or Off-Peak).

Use the following variable names in your pseudocode:

Name	Use
Membership	True for member; Otherwise, False.
Ticket_Type	"Economy" or "Business"
Period	"Peak" or "Off-Peak"

The function should print one of the following outputs:

- "20% discount"
- "10% discount"
- "No discount"

[5]

```
OUTPUT "Please enter Membership type:"
INPUT Membership
OUTPUT "Please enter Period:"
INPUT Period
OUTPUT "Please enter Ticket Type type:"
INPUT Ticket_Type
IF Membership = "Y" AND Period = "Off-Peak" AND Ticket_Type = "Business"
    OUTPUT "20% Discount"
ELSE IF Membership = "N" AND (Period = "Peak" OR Ticket_Type = "Economy")
    OUTPUT "No Discount"
ELSE
    OUTPUT "10% Discount"
```


The members are issued membership cards with unique seven-digit membership numbers. The last digit is a check digit generated using the Luhn algorithm. The validity of a membership number can be checked with the following steps :

1. Starting with the first digit from the left, double the value for each digit in the even positions (2nd, 4th and 6th):
 - a. if the doubled value is smaller than 10, do not change the doubled value;
Otherwise, deduct 9 from it
 - b. sum all the doubled values
2. Sum all the values of the digits in the odd positions (1st, 3rd, 5th and 7th)
3. Find the total by adding the values obtained in steps 1b and 2
4. The membership number is valid if the total is divisible by 10;
Otherwise, it is invalid.

(d) Determine if the following two membership numbers are valid:

- 2316214
- 2543543

[6]

For 2316214: Total = $(6+(12-9)+2)+(2+1+2+4) = 20$, divisible by 10, membership is valid

For 2543543: Total = $((10-9)+6+8)+(2+4+5+3) = 29$, not divisible by 10, membership is invalid

(e) The use of check digits is one of the validation techniques.

(i) State the purpose of validation.

[1]

It is used to check if the data conforms to an expected form or format.

- (ii) State **two** types of error that a check digit usually detects. Explain by demonstrating how the Luhn algorithm is used for each type of error. [4]

A check digit usually detects transposition errors where numbers are mistakenly switched when typed. It is also used to check for transcription errors which are data entry errors made by humans

- (f) (i) State the purpose of verification. [1]

Its purpose is to check if data has been transferred accurately from the original source.

- (ii) State two methods of verification. [2]

The two methods of verification are by double-entry or proof-reading.

- 4 A fitness company *Just-Fitness* provides a phone application (“app”) for customers to book their training sessions and enter the gym.

The company recently updated its app to reward customers who jog actively. The app will access the phone’s location and time to compute the speed and distance covered during the jogging session. Reward points will be awarded if the speed is above a certain minimum requirement.

The reward points earned can be used to pay for the membership fee or other merchandise in the gym.

After updating the app, the customers will receive the following notification each time they want to use the app:

New Feature Unlocked!
Earn reward points while you exercise.

☐ I accept the use of my personal data for the purposes of the current marketing promotions, for profiling, and or market analysis activities aimed to receive promotion, discounts and targeted communications based on the provided data.

**Access your location
while using the
“Just-Fitness” app.**

Allow

Don't
Allow

If a customer does not allow the phone location to be accessed, the app will not be loaded.

- (a) Give two reasons why the above notification is required under the Personal Data Protection Act (PDPA). [4]

To fulfil the Notification Obligation, businesses are required to inform customer of how their personal data will be collected and used.

To fulfil the Consent Obligation, businesses are required to allow customers to give and withdraw consent.

- (b) Describe one positive social impact made with this updated feature in the app. [2]

Encourage a more physically active lifestyle in society due to updated incentives from participating in the new rewards promotion.

- (c) Describe one ethical issue associated with the installation of the new update in the app. [2]

Customers currently need the app to book training sessions and enter the gym. It is unethical to force customers to give an all-or-nothing consent to continue using the app to access the gym and book sessions, when they may not want to disclose their location. This seems to go against the existing terms and conditions that were previously set.

- (d) Give a suggestion regarding the installation of the updated app to address the concerns arising from the ethical issue described in **part (c)**. [2]

Create consent for different categories so that customers can choose for which purposes their data can be used for, so that they can continue accessing the gym and book training sessions, while still having the option to choose to agree (or decline) to disclose their location to take part in the latest rewards.

The programmer implemented the speed module in the updated app using Object-Oriented Programming (OOP). In his program code, he defined the base *class* and sub-classes with methods to gather and process the data of the *objects*.

- (e) State an OOP concept and explain how it can help to reduce software development time. [3]

The concept is inheritance. In this concept, sub-classes can inherit code from the base class. This hierarchy/structure of writing code promotes reusing code and can help reduce software development time.

- (f) Explain the difference between a 'class' and an 'object'. [2]

A class is a blue print/template that defines the objects created. An object is an instance that was created from the blue print/class.

- (g) Explain the meaning of the term 'encapsulation'. [2]

Encapsulation is a concept where the attributes and the methods are binded together as a single unit. Attributes are hidden from view and access to them are managed by the methods provided.

- (h) Explain the meaning of the term 'polymorphism'. [2]

Polymorphism is where objects that are not the same class can have a common parent class. Thus, they implement a common method name to facilitate code generalisation. The same method name can behave differently for different sub-classes of the parent class.

A project team at another company selling Personal Mobility Devices (PMD) saw the potential in *Just-Fitness*'s updated app. They adapted the feature for their PMD app to compute the speed using the phone's location and time.

- (i) State a legal issue involved and suggest the correct approach to take to avoid the legal issue. [2]

Copyright Issue/Intellectual Property. The app design and feature is *Just-Fitness*'s intellectual property. The project team from another company selling PMDs should make an offer to *Just-Fitness* to acquire it or purchase a license to modify and use the feature.

- 5 A website allows customers to book rooms in a resort at least one day before the start of a staycation. Customers pay a 30% deposit at the time of booking and the balance when they check in at the resort.

At the time of booking, the customer is required to submit the following data through the website:

- Customer data, including the passport number
- Booking date
- Staycation start date
- Staycation end date
- Type of room

The room types and cost are as follows:

- Standard Room (SR) - \$150 per day
- Deluxe Room (DR) - \$200 per day
- Family Suite (FS) - \$280 per day

A customer may make more than one booking. A sequential booking number will be auto generated when the customer pays the deposit to confirm the booking.

An example of the document generated for the customer to check in at the resort:

BOOKING RECEIPT				
Name:	Mr John Tan (Passport No.: SIN253486K)			
Email:	johntan@gmail.com			
Booking No.:	2023-007563			
Booking Date:	14/09/2023			
Room Type:	DR			
Start Date	End Date	Days Charged	Rate	
23/12/2023	26/12/2023	3	\$200	\$600.00
Deposit Paid:				\$180.00
Amount Due:				\$420.00

(a) The resort models this web application using a relational database.

- (i) The database needs a few tables to store the data for this application. Draw the Entity-Relationship (E-R) diagram showing the tables and the relationships between them. [6]



- (ii) A table description can be expressed as:
TableName (Attribute1, Attribute2, Attribute3, ...)
The primary key is indicated by underlining one or more attributes.

Write table descriptions for the tables you identified in **part (i)**. [6]

Customer (PassportNumber, Name, EmailAddress)

Room (RoomType, Cost)

Booking (BookingNumber, PassportNumber*, BookingDate, StartDate, EndDate, RoomType*)

- (b) The room rates fluctuate according to the low and high peak seasons. Describe how you would modify tables in **part (a)** to ensure that the correct rates are recorded in the database. [2]

Add a field in the Booking table to record the rate on the day when the customer made the booking.

- (c) Explain by giving two reasons why the resort should use a relational database instead of a NoSQL database. [2]

Any two of the following reasons:

- the required database has a fixed schema
- the database should be ACID compliance
- may perform more advanced queries in RDBMS

Customers are required to submit their *personal data* like name, passport number and email address when they do a booking.

- (d) Define the term “*personal data*”. [2]

Personal data are data, whether true, false or has changed, which can be used to identify an individual , either with the data alone or together with other information.

- (e) Describe how the website protects the personal data when they are transmitted from a customer’s web browser to the server. [2]

The website should use HTTPS (Hypertext Transfer Protocol Secure), instead of HTTP, which will encrypt the data transmitted between the web browser and server.

- (f) Describe **two methods** to prevent unauthorised access to the customers’ personal data stored in the database. [2]

- Password protect the database so that only those authorised can access the data.
- Provide different access rights to different personnels according to their job requirements for accessing the customers’ data.

- (g) Describe **two methods** to prevent remote access to the customers' data. [4]

Any two of the following:

- Set up a firewall. Configure the Access Control Lists (ACLs) to allow traffic only from trusted IP addresses.
- Divide the LAN into segments and place the database server in a restricted network segment that only authorized systems can access.
- Prevent access to the database via Virtual Private Network (VPN) for all and only grant VPN access to limited specific personnels.

- (h) State a possible threat of losing the customers' data and suggest a method to prevent it. [2]

Data corruption due to virus. Install an updated anti-virus software and regularly backup the data.

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ANSWER SHEET

Hash Table for Question 2 (c):

index	Hash Value	Customer's Data (Order No., Name, Phone No.)
0		
1		
2		
3	3	62423, Aileen Goh, 84621039
4		
5		
6		
7		
8		
9		