



ANDERSON SERANGOON JUNIOR COLLEGE
JC2 Preliminary Examination 2024
Higher 2

COMPUTING

9569/01

Paper 1 (Written)

11 September 2024 (Wednesday)

3 hours

READ THESE INSTRUCTIONS FIRST

An answer booklet will be provided with the question paper. You should follow the instructions on the front cover of the answer booklet. If you need additional writing paper ask the invigilator for a continuation booklet.

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 **6** printed pages and **0** blank page.

Anderson Serangoon Junior College

- 1 A gym's membership management system uses Object Oriented Programming (OOP) in its design. The gym offers three types of membership: Basic, Pro and Family.

For every gym member, its member ID, name, mobile number and membership start date need to be stored. The system should also allow for the annual renewal of membership.

Basic members are only allowed non-peak hours gym usage daily. There are no restricted hours for Pro and Family memberships.

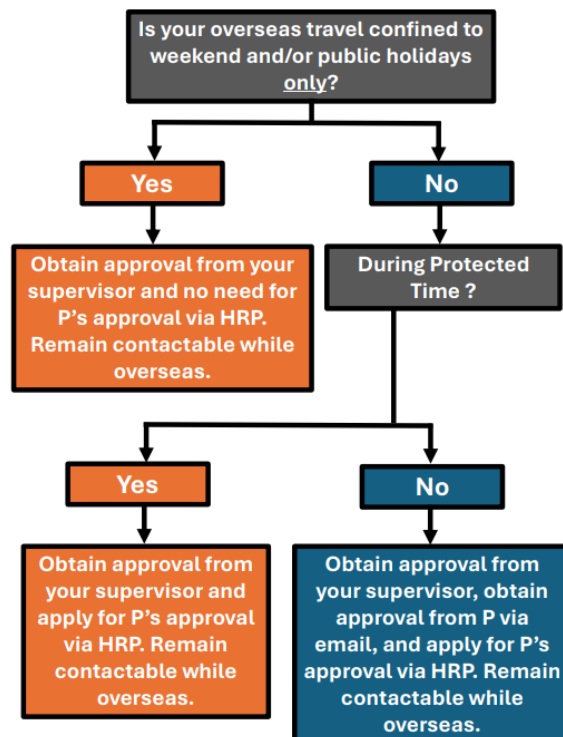
Pro members are entitled to 10 complimentary training sessions with a qualified personal trainer of choice.

For Family members, up to three family members' names can be stored.

Basic members will be charged a monthly fee, while Pro members will be charged 1.3 times this rate. Each Family member will be charged 1.5 times this rate, with each additional family member being charged 0.5 times this rate. Membership fees are charged via a `calculate_fee()` method at the start of each membership cycle.

- For the Basic base class, explain how encapsulation can be achieved. [2]
- Explain the rationale of creating the Pro and Family subclasses. [2]
- How does this class relationship demonstrate polymorphism? [3]
- Draw a class diagram for this system showing the base class and the derived classes, including relevant attributes and methods necessary for the system to function. [6]
- The gym business owner wishes to launch a referral promotion for members to refer their friends to join the gym. Each successful referral will extend an existing member's current membership validity period by one month. Describe the necessary change(s) that can be made to the class diagram to accommodate this updated requirement. [2]

- 2 ABC School has the following workflow for teachers to apply for vacation leave.



Note:

- Each teacher has a reporting supervisor
- HRP (Human Resource Portal) is an online platform for teachers to access services such as leave application

- (a) Convert the workflow to a decision table, showing all possible conditions and actions. [3]
- (b) Simplify your decision table in (a) by removing redundancies. [2]
- (c) Translate the decision table to pseudocode using appropriate variables. [4]

3 The Fibonacci sequence is a series of numbers in which each number is the sum of the two previous numbers: 1, 1, 2, 3, 5, 8, ...

- (a) Draw a program flowchart to iteratively compute the n th Fibonacci number, $n > 0$. [3]
- (b) The following pseudocode shows an algorithm to iteratively compute the n th Fibonacci number:

```

01 FUNCTION fibonacci_iterative(n)
02     IF n <= 2
03         return n
04     ENDIF
05     a = 1
06     b = 1
07     FOR i FROM 2 TO n
08         temp = a + b
09         a = b
10         b = temp
11     ENDFOR
12     RETURN b
13 ENDFUNCTION

```

Identify (specify line numbers) and rectify two logic errors with the above algorithm. [4]

- (c) Produce the pseudocode for a `fibonacci_recursive(n)` algorithm to determine the n th Fibonacci number recursively. [3]
- (d) Why is recursive Fibonacci less efficient than iterative Fibonacci for large n ? [2]
- (e) Suggest a way to overcome the issue identified in (d). [3]
- 4 (a) What advantage does binary search and merge sort have in common compared to linear search and bubble sort? [3]
- (b) For a small dataset which is almost sorted, explain if quick sort is a suitable sorting algorithm. If not, suggest and justify a suitable sorting algorithm. [3]
- (c) For a large dataset with duplicates, explain if quick sort is a suitable algorithm. If not, suggest and justify a suitable sorting algorithm. [3]
- (d) Explain why the efficiency of merge sort is $O(n \lg n)$. [4]

- (e) For the purpose of illustration, using the integers 1 to 15 inclusive and each only once (i.e. no duplicates), give and explain a **best case** dataset scenario for quick sort if the middle element is selected as the pivot.

For example, for integers 1 to 5 inclusive and no duplicates, a **worst case** dataset scenario for quicksort is [5, 4, 3, 2, 1] if the first element is selected as the pivot because the pivot will always have maximum number of elements in the left array and minimum number or no elements in the right array, resulting in the maximum number of recursive calls and worst case efficiency of quadratic time complexity $O(n^2)$.

[3]

- 5 Every year, there is a large number of people balloting for a fixed and limited number of National Day Parade (NDP) tickets. For NDP2024, successful applicants were notified via email. While official figures are not disclosed, about or more than 15,000 spectators were reported by mainstream media.

Moving forward, to prevent the problems of bounced emails and phishing, the organising committee would like to provide a web service to allow applicants to check their application status online.

While there is no perfect data structure, after careful consideration, the organising committee is contemplating the use of a hash table to store successful applicants' identification and their status.

- (a) Justify why a hash table would be a suitable data structure in this context. [3]
- (b) What would be a suitable hash table size and why? [2]
- (c) To handle collision resolution, the developer decides to implement quadratic probing. What problem does quadratic probing address? [2]
- (d) Devise an algorithm to perform hash table search using quadratic probing collision resolution strategy. [5]
- (e) Compare and contrast the advantages and disadvantages of using an array over a hash table to store successful applicants' identification and ballot status information. [3]

- 6 A theatre has an existing computer system that stores customer bookings in a spreadsheet. The following are some sample entries recorded:

CustomerName	Email	ShowName	ShowTime	Duration	Seats	Amount
Amil Bin Osman	amilbo@email.com	Miss Saigon	2024-08-30 1930	160	F09	\$128.00
Bridgette Smith	bridgettes@email.com	Playing with Fire	2024-09-06 2000	90	G07, G08, G09, G10	\$220.00
Chen Tiong Kai	chentk@email.com	Miss Saigon	2024-08-30 1930	160	J20, J21, J22	\$196.00

- (a) Explain the problems arising using this method of storing booking records. [2]
- (b) State why the table is not in First Normal Form. [1]

A relational database in Third Normal Form is to be used for the updated booking system. The database contains three tables: *Customer*, *Show* and *Booking*.

(c) Create an entity-relationship diagram for the database. [3]

(d) One of the tables is designed as follows:

Customer (*CustomerID*, *CustomerName*, *Email*)

Give the table specification for the other two tables in the database, clearly identifying all primary and foreign keys required. [3]

(e) In the normalised database design above, explain why the *Booking* table requires a composite key. [2]

(f) A practical alternative to a composite key is to use a system-generated primary key. Discuss the pros and cons of this approach. [2]

7 Recently, CNA reported that "The Ministry of Education (MOE) has taken legal action against "relevant contractors" following a Mobile Guardian cyberattack that affected 13,000 users from 26 secondary schools."

Source: <https://www.channelnewsasia.com/singapore/mobile-guardian-cybersecurity-breach-attack-legal-action-contractors-chaun-chun-sing-4597791>

(a) From the article:

About one in six of the affected users lost some data due to the cybersecurity breach suffered by the device management app, Minister for Education Chan Chun Sing said in parliament on Tuesday (Sep 10).

Less than 5 per cent were unable to recover all their data as their devices had not been backed up before the Aug 4 breach, he added.

Explain the significance of backup and the difference between backup and archive in this context. [3]

(b) From the same article:

"Prior to the Aug 4 incident, Mobile Guardian suffered a data breach in April due to poor password management practice. A glitch was also reported in July due to human error."

(i) Suggest two ways to harden the password management system in a networked environment. [2]

(ii) What could be a likely 'human error' and suggest one possible preventive and one possible corrective measure. [3]

(c) The article continues...

"IMPACT ON STUDENTS

The 13,000 personal learning devices that were remotely wiped out represented about 8 per cent of devices used by the secondary school population.

MOE deployed 300 additional IT engineers and staff to help students, and provided instruction sheets to those who wanted to troubleshoot on their own. All devices were restored for use last month.

Schools provided hardcopy resources and supported students who were emotionally affected, said Mr Chan.

Deadlines were extended and weighted assessments were postponed where needed, he added.

At the school level, adjustments have been made according to the school's specific circumstances and needs."

Suggest two other support measures to mitigate the impact on students.

[2]

(d) The article continues...

The attack surface is "wide" and it is not possible to "defend everywhere with the same resources, with the same level of focus", he said.

At the national level, critical information infrastructure gets the most resources, and the level of security in other areas would vary depending on the system, said Mr Chan, describing it as a tiered and risk-based approach.

"It would not be practical to try to achieve the same level of security for all systems, he said."

In the context of schools, propose and justify how you would adopt a tiered and risk-based approach for online services used by students and teachers. Highlight the roles of firewall (filtering function), intrusion detection system (IDS), intrusion prevention system (IPS), encryption, digital signature, and authentication.

[7]

END OF PAPER