RAFFLES INSTITUTION
2025 YEAR 6 PRELIMINARY EXAMINATION

CANDIDATE NAME

CLASS 25

COMPUTING

9569/01

Paper 1 Written

September 2025

3 hours

READ THESE INSTRUCTIONS FIRST

Writing papers will be provided with the question paper.
Write your name and class on all the work you hand in.
Write in dark blue or black pen.
You are reminded of the need for clear presentation in your answers.
Staple the provided coverpage in front of your answer script.

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.

FOR EXAMINER'S USE							
Q1	Q2	Q3	Q4	Q5	Q6	Q7	TOTAL
							100

This document consists of **8** printed pages.

1 A company operates a ride-hailing platform that allows passengers to book rides via a mobile app. A relational database is being designed to manage rides, drivers, passengers, and payments.

Each ride includes:

- a unique RideID
- PickupLocation
- DropoffLocation
- RideDateTime
- Status (e.g., completed, cancelled, ongoing)
- DriverID
- PassengerID

Each driver includes:

- a unique DriverID
- FullName
- VehicleNumber
- LicenseExpiryDate
- ContactNumber

Each passenger includes:

- a unique PassengerID
- FullName
- PhoneNumber
- EmailAddress

Each payment includes:

- a unique PaymentID
- RideID
- PaymentMethod (e.g., credit card, e-wallet)
- FareAmount
- PaymentStatus (e.g., paid, pending)

(a) Draw an entity-relationship (ER) diagram showing the **four** entities and the relationships between them. [3]

(b) Write table definitions for each of the tables so that they are in third normal form, using this format: `TableName (Attribute1, Attribute2, Attribute3, …)`

(i) Ride [2]

(ii) Driver [2]

(iii) Passenger [2]

(iv) Payment [2]

(c) **(i)** The company wants to know which drivers earned the most.

Write an SQL query to calculate the total fare amount collected by each DriverID, and sort the results in descending order of total fare. [4]

(ii) Write an SQL query to update the PaymentStatus of a ride with RideID = 'R7645' to 'paid'. [2]

(d) The company is planning to collect customer reviews and use them to improve driver performance.

Justify three reasons why a NoSQL database might be more suitable than a relational database for storing customer reviews for the ride-hailing platform.

[3]

During the booking process, the following personal data is collected and stored:

- From the passenger: full name, mobile number, pickup and drop-off location, and ride history.
- From the driver: full name, contact number, vehicle number, driving license number, and real-time location when online.

The system also stores in-app messages between drivers and passengers.

(e) From the perspective of a passenger, explain **two** concerns you may have about how your personal data is used or shared. [2]

(f) From the perspective of a driver, explain **two** responsibilities you have under PDPA when handling passenger data. [2]

(g) To prevent misuse of passenger information, the company plans to work with a third-party fraud analysis firm.

What actions should the company take before sharing personal data with this vendor? [2]

2 A large e-commerce company is building its order management system. As millions of customers place, modify, and cancel orders daily, choosing the correct data structures is critical for performance.

The system must support the following operations efficiently:

- `AddOrder(orderID)`: Adds a new order with a unique orderID
- `CheckOrderExists(orderID)`: Checks whether an order exists
- `GetMostRecentOrder()`: Retrieves the latest order placed
- `GetAllOrdersSorted()`: Returns all orders sorted by orderID

The development team is considering various data structures:

- Unordered List (Array or Linked List)
- Hash Table
- Binary Search Tree (Self-balancing)
- Stack

(a) For each operation above, select the most suitable data structure from the list provided (Unordered List, Hash Table, BST, Stack), and justify your choice using Big-O notation. [4]

(b) Explain why using a linked list to implement `CheckOrderExists(orderID)` would be inefficient at scale. [2]

(c) The company is considering using a hash table to manage all active orders. Explain why using a hash table is not ideal, and propose a suitable data structure. [3]

(d) During a Black Friday sale, the sales volume typically increases dramatically. Certain popular items may have limited stock, so it is important for the system to support a feature that allows merchants to fulfil orders in chronological order.

You are tasked with selecting the most appropriate data structure to support this operation.

You may choose from the list of data structures provided above, or propose an alternative.

Justify your choice clearly. [2]

3 A robotics company is developing a simulation system for different types of warehouse robots. These robots help with tasks such as transporting items, sorting packages, and restocking shelves.

Each robot stores the following common data:

- `robotID`: a unique robot ID
- `status`: status (active or charging)
- `batteryLevel`: current battery level (initialised to 100)
- `location`: location in the warehouse (zone ID as a string)

There are three types of robots:

- Transport robots carry items from one zone to another. These robots have a maximum load of 100kg (`kgCarried`).
- Sorting robots identify and sort parcels. They store the number of parcels sorted per hour (`parcelsPerHour`)
- Restock robots move items from the storage area to shelves. They store the number of shelves restocked per cycle (`shelvesRestocked`).

Each robot has a method `PerformTask()`:

- A transport robot's battery level decreases by 5% for every 10kg it carries.
- A sorting robot's battery level decreases by 2% for every 10 parcels sorted.
- A restock robot's battery level decreases by 3% per shelf restocked.

When a robot's battery level reaches 10% or less, its status is set to charging.

Object-oriented programming will be used to simulate these robots.

(a) Draw a class diagram for the simulation described above.
Include:

- the superclass
- any subclasses
- inheritance
- attributes
- appropriate methods [8]

(b)

(i) Describe instantiation, with an example from simulation. [2]

(ii) Describe encapsulation, using an example from the simulation. [2]

(iii) Describe inheritance, using an example from the simulation. [2]

(iv) Describe polymorphism, using an example from the simulation. [2]

(c) The system includes validation for the number of kilograms carried per trip by a transport robot. Provide examples of test data for the input variable `kgCarried`. [4]

4 The function `EvaluatePostfix` is designed to evaluate a postfix arithmetic expression at runtime.
The expression is stored as a queue of tokens (either integers or operators) from left to right.

For example, the postfix expression `5 2 - 3 *` is stored as the queue `[5, 2, '-', 3, '*']`,
which corresponds to the infix expression `(5 - 2) * 3`.

The pseudocode is given below:

```
01 FUNCTION EvaluatePostfix(Tokens : QUEUE) RETURNS INTEGER
02     DECLARE Stack AS EMPTY STACK
03     REPEAT
04         Token ← DEQUEUE Tokens
05         IF Token IS INTEGER THEN
06             PUSH Token TO Stack
07         ELSE
08             A ← POP Stack
09             B ← POP Stack
10             IF Token = '+' THEN
11                 PUSH (B + A) TO Stack
12             ELSE IF Token = '-' THEN
13                 PUSH (B - A) TO Stack
14             ELSE IF Token = '*' THEN
15                 PUSH (B * A) TO Stack
16             ELSE IF Token = '/' THEN
17                 PUSH (B DIV A) TO Stack
18             ENDIF
19         ENDIF
20     UNTIL Tokens IS EMPTY
21     RETURN POP Stack
22 END FUNCTION
```

(a) Copy and complete the trace table given to determine the output of `EvaluatePostfix` when
`Tokens = [4, 5, 6, '*', '+', 2, '-']`.

Token	Action	Stack Contents
4	Push 4	[4]
5	Push 5	[5, 4]

[4]

(b) Explain why it is important to POP operand A before operand B, as shown in lines 8 and 9. [1]

(c) Add code to the pseudocode so that it can also handle exponentiation (^). Indicate between which lines this code should be inserted. [3]

(d) Identify **one** possible runtime error that could occur in the code above. Describe how it may happen, and explain necessary changes to the code to prevent it. [4]

5 A microcontroller stores sensor data in binary and transmits the values to a monitoring system, which displays the readings in hexadecimal.

The system receives the decimal reading 178, which must be stored and displayed in both binary and hexadecimal.

(a) Showing your working clearly, convert the decimal number 178 to:

(i) binary, [2]

(ii) hexadecimal. [2]

The following function is used to convert a non-negative decimal number into its binary equivalent.

The algorithm uses a loop to divide the number by 2 repeatedly and builds the binary string.

```
1  FUNCTION ConvertToBinary(number: INTEGER) RETURNS STRING
2    DECLARE result ← ""
3    WHILE number > 0 DO
4       remainder ← number MOD 2
5       result ← <insert code here>
6       number ← number DIV 2
7    ENDWHILE
8    RETURN result
9  ENDFUNCTION
```

(b) What code should `<insert_code_here>` be so that the binary digits are in the correct order? [1]

(c) Rewrite the `ConvertToBinary` function as a recursive version that returns the binary string. [4]

6 A restaurant has introduced a promotional reward system for its customers. The rewards offered depend on the following rules:

- Customers who are members receive a 10% discount on their bill, regardless of the day or amount spent.
- On Tuesdays, as part of the "Dine-out Tuesday" promotion, all customers receive a $5 dining voucher.
- If a customer spends $50 or more on a single bill, they receive an additional $10 dining voucher, but this applies only to non-members.

(a) Create a decision table to show these conditions and actions. [4]

(b) Simplify your decision table by removing redundancies from the decision table. [2]

7 A food delivery company operates a fleet of riders who rely on a mobile app to receive orders and navigate to customers. The app communicates with a central server located in the company's data center. Riders connect to the internet using either public Wi-Fi or mobile networks as they move through different locations.

(a) When a rider logs into the app, the device sends a request to `http://api.foodtrack.sg`.
Explain the role of the Domain Name System (DNS) in this process. [2]

(b) Each rider's device has both a MAC address and an IP address.

(i) State the purpose of each type of address. [2]

(ii) Explain why both are necessary in network communication. [2]

(c) Describe the structure of a data packet that may be transmitted between the rider's device and the central server.
Your answer should include **three** components commonly found in a packet, and explain clearly the purpose of each component. [6]

The company is exploring ways to improve the system's resilience and efficiency, especially in areas with weak or unstable internet connectivity. One proposal is to allow rider devices to share updates with each other using a Peer-to-Peer (P2P) model.

(d) Explain **one** advantage and **one** disadvantage of using a Peer-to-Peer model in this food delivery scenario.

Your answer should be based on how the model helps or hinders delivery operations in real-world conditions. [4]