

TEMASEK JUNIOR COLLEGE

2025 JC2 PRELIMINARY EXAMINATION

Higher 2



COMPUTING

9569/01

Paper 1 Written

17th September 2025

3 hours

READ THESE INSTRUCTIONS FIRST

An answer booklet will be provided with this question paper. You should follow the instructions on the front cover of the answer booklet. If you need additional answer 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.

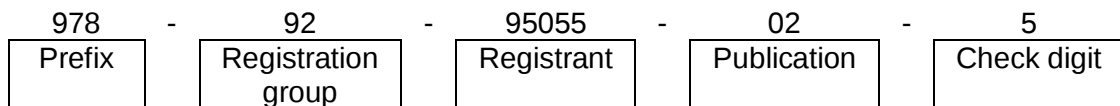
This document consists of **7** printed pages and **1** blank page.

- 1 An ISBN is an International Standard Book Number and is a unique identifier for each book.

Each ISBN consists of 13 digits, which is made up of 5 elements with each element being separated by spaces or hyphens. Three of the five elements may be of varying length:

- **Prefix element** – currently this can only be either 978 or 979. It is always 3 digits in length
- **Registration group element** – this identifies the country, geographical region, or language area participating in the ISBN system. This element may be between 1 and 5 digits in length
- **Registrant element** – this identifies the publisher or imprint. This may be up to 7 digits in length
- **Publication element** – this identifies the edition and format of a specific title. This may be up to 6 digits in length
- **Check digit** – this is always the final single digit that mathematically validates the rest of the number. It is calculated using a Modulus 10 system with alternate weights of 1 and 3.

An example of an ISBN with check digit 5 is shown below:



- (a) Describe a purpose of the check digit in an ISBN. [2]

- (b) Suggest another suitable validation technique for ISBN. [1]

A school library system needs to store and search for information about books using their unique ISBNs. New books are added into the library inventory and damaged or older books are condemned from time to time.

The developers propose the use of a hash table to store and retrieve the book records.

- (c) Explain how the library system would use a hash function and a hash table to store and search for books by their ISBNs. [3]

- (d) Give **three** features of an effective hashing algorithm. [3]

- (e) Explain the meaning of a collision in this context. [2]

- (f) Describe **one** method that can be used to handle the consequence of a collision. [2]

Students on an internship with the library ask their developer mentors why the book records, ordered by their ISBNs, were not stored in a linked list instead.

- (g) Describe **one** disadvantage of storing and searching the records ordered by ISBNs using a linked list. [2]

- 2 A program implements a Merge Sort algorithm to order values into ascending order.

The contents of an array are shown:

12	10	5	1	24	9	6
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- (a) Explain how the Merge Sort algorithm sorts the data in the array into ascending order. [3]
- (b) Using Big-O notation, state the worst-case time complexity of Merge Sort. [1]
- (c) The Merge Sort algorithm uses recursion.

- (i) State **three** features of a successful recursive function. [3]

- (ii) State the purpose of the given pseudocode function:

```

FUNCTION iterative (string1)
    left = 1
    right = LENGTH(string1)
    WHILE left < right
        IF string1[left] <> string1[right]
            RETURN FALSE
        END IF
        left = left + 1
        right = right - 1
    END WHILE
    RETURN TRUE
END FUNCTION

```

[1]

- (iii) Rewrite the pseudocode function in (c)(ii) using recursion. [3]

- 3** A software company is writing a program for a vehicle hire business. Both cars and vans are available for hire.

For all vehicles, the data that will be stored include:

- Vehicle Registration Number (VRN)
- Total distance travelled (km)
- Date hired
- Date of return
- Cost per day
- Availability for hire

For cars, the additional data stored include:

- Fuel type (petrol, diesel, electric, hybrid)

For vans, the additional data stored include:

- Maximum load (kg)

The odometer in the vehicle displays the total distance the vehicle has travelled since manufacture.

When a vehicle is hired:

- total distance travelled is set to the odometer's value
- date hired is set to the current date
- date of return is set to the date the vehicle is expected to be returned
- availability for hire is set to FALSE.

When a vehicle is returned:

- hire cost is returned as the cost per day multiplied by the number of days the vehicle was hired
- total distance travelled is set to the odometer value
- date of return is set to the current date
- availability for hire is set to TRUE.

Object-oriented programming will be used to model this situation.

- (a)** Draw a class diagram that shows the following for the situation described above.

- the superclass
- any subclasses
- inheritance
- properties
- appropriate methods.

[8]

- (b)** Explain how encapsulation helps to prevent inadvertent data modification using examples from this situation. [2]

- (c)** Explain how inheritance promotes code reuse using examples from this situation. [2]

The programmer uses a database to store vehicle hire data. Each row in the table represents a vehicle hire record. A vehicle must be hired for a minimum of one day.

Vehicle hire data is stored in the following table:

VRN	TotalDistance	DateHired	DateReturned	CostPerDay	Availability	FuelType	MaxLoad

(d) (i) Identify the primary key for the above table. [1]

(ii) Identify suitable SQL data types for the following columns:

1. DateHired [1]

2. Availability [1]

(e) Explain why the above table is not in Third Normal Form (3NF). [3]

A database consultant rewrites the above table into the following table descriptions:

Vehicle (VRN, Type, TotalDistance, CostPerDay, Availability)

Hire (VRN, DateHired, DateReturned)

Car (VRN, FuelType)

Van (VRN, MaxLoad)

The vehicle type is stored as either 'Car' or 'Van'.

(f) Identify the foreign key(s) of the tables Hire, Car and Van. [1]

(g) Draw an entity-relationship (ER) diagram showing the four tables and the relationships between them. [4]

(h) Write an SQL query to retrieve from the above tables the VRNs of hybrid cars and their latest date of hire. [6]

- 4 A software company is developing a print server that handles print jobs from multiple users. Each print job has a job ID and the number of pages.

- (a) The print server manages the print jobs with a linear queue.
Explain why a linear queue would be appropriate for regular print jobs. [2]

The company decides to implement the print queue as a circular queue using a static array of size 5.

- (b) Explain **one** advantage and **one** disadvantage of using a circular queue instead of a linear queue for this situation, where both queues are implemented using a static array of the same size. [4]

- (c) Draw a diagram showing the state of a circular queue after the following operations, showing the positions of front and rear pointers:
1. Enqueue jobs: 101, 102, 103, 104
2. Dequeue two jobs
3. Enqueue jobs: 105, 106 [3]

- (d) The print server keeps a history of completed print jobs in a stack data structure.

- (i) Explain how a stack data structure would be appropriate for implementing a "restore" feature that allows the system administrator to restore recently completed print jobs back to the queue. [2]

- (ii) Write pseudocode for a procedure `restoreJobs` that takes three parameters: the history stack, the print queue and an integer N . The function should restore the N most recently completed jobs from the history stack back to the print queue, maintaining their original print order. [6]

- 5 A company, ImageMaps, wishes to develop an application that scans a user's device for photographs, detect the associated location, and display the images on a map using the associated locations.

- (a) State **two** actions the company must take regarding the collection and use of personal user data to comply with prevailing personal data protection laws. [4]

- (b) ImageMaps needs to store a large quantity of data that will not be frequently accessed. State how they can reduce costs while doing so. [2]

- (c) State whether a native or web application is more suitable for ImageMaps's application. Explain your answer. [3]

- (d) When data is transmitted between a user's device and ImageMaps' server, it is divided into packets that travel through the network. Describe how networking protocols address the following problems:

- (i) Data packets may arrive out of order and require reassembly [2]

- (ii) Data packets may be corrupted in transit. [2]

- 6** A commercial bank is strengthening its cybersecurity framework after experiencing multiple security breaches.
- (a)** **(i)** Explain how a Trojan horse differs from a worm in terms of propagation and payload delivery. [2]

(ii) Describe **two** characteristics that make ransomware particularly dangerous to financial institutions. [2]
 - (b)** The bank has deployed a firewall and Intrusion Prevention System (IPS). Explain why implementing both a firewall and IPS provides better security than using either system alone. [2]
 - (c)** The bank must choose between biometric authentication and security tokens for employee access to sensitive systems. Evaluate which method would provide better security, giving **two** reasons for your choice. [3]
 - (d)** Describe the complete process of generating and verifying a digital signature for an electronic funds transfer request. [4]
 - (e)** A bank employee wishes to email a contract document to a customer. To prevent tampering with the contract document, he attaches his digital certificate to the email alongside with the document. Explain why this is insufficient to ensure the integrity of the document. [2]

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