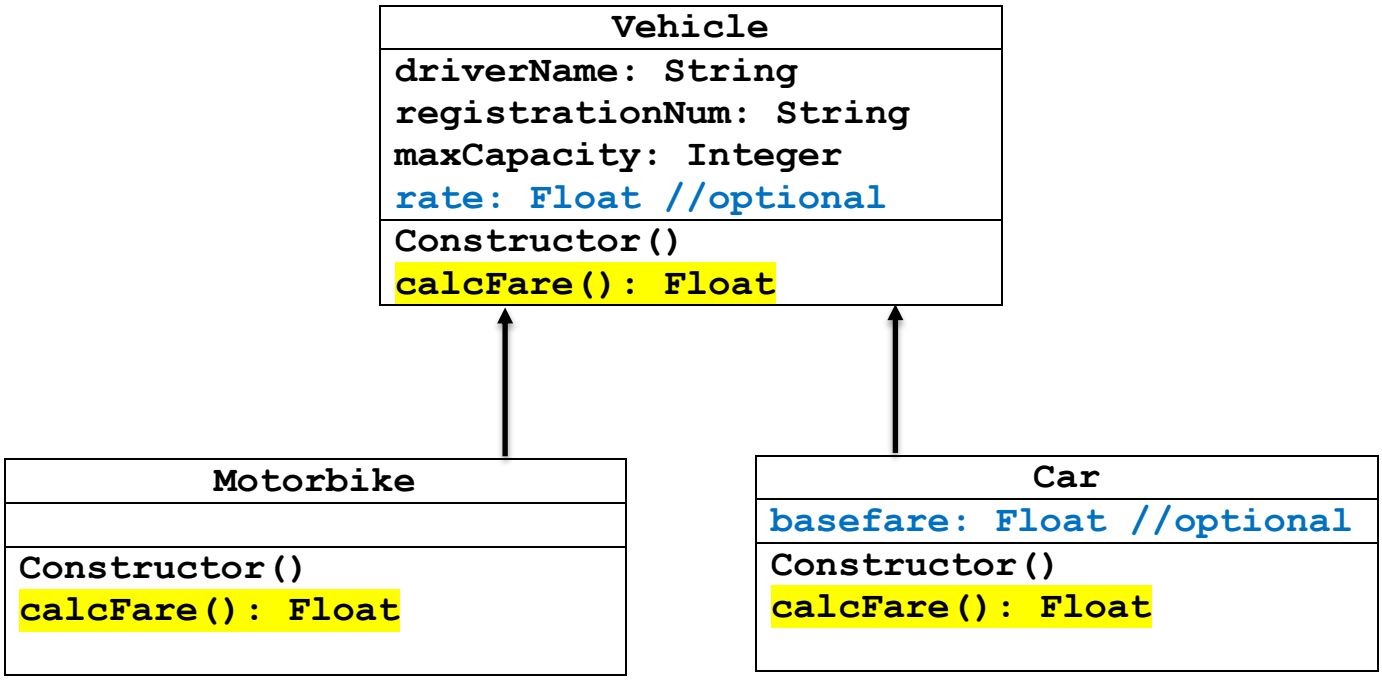
Marking Scheme

2. JRide – Object-Oriented Modelling (Suggested Answers)

(a) Class diagram description (6 marks)

- Attributes are properties belonging to an instance (i.e.: object) of a class.
- Distance and fare are not properties of `Vehicle` object.
- The question did not mention `rate` and `basefare` stored in the system. However, if you were to include them, then rate would be in the Vehicle class (inherited by both `Car` and `Motorbike`) while basefare would be in the `Car` class.
- Fare is calculated using the `calcFare()` method.
- Methods such as `getFare()` are interpreted as an assessor method.



1m – `Car` and `Motorbike` child classes with correct arrows

2m – Polymorphism `calcFare()` in both child classes

1m – Attributes in `Vehicle` parent class

1m – `calcFare()` method in `Vehicle` parent class

1m – No additional attribute in child classes

(b) Introducing Driver class – describe update (3 marks)

Describe questions must be answered in proper sentence and paragraph(s).

No mark awarded if only a new class diagram is drawn.

1m – Add class `Driver` with attributes: `name`:String, `licenceNo`:String, `yearsExperience`:Int.

1m – Replace `Vehicle.driverName` with `Vehicle.driver` where the attribute is a `Driver` object.

1m – `Vehicle` and `Driver` classes share a HAS-A association.

For example:

A new class `Driver` should be introduced with the attributes `name`, `licenceNo`, and `yearsExperience`. In the `Vehicle` class, the existing attribute `driverName` should be replaced with `driver`, where `driver` is an object of the `Driver` class. This modification establishes a HAS-A relationship between `Vehicle` and `Driver`.

(c) Encapsulation (2 marks)

1m – Encapsulation is used to hide the values or state of a structured data object inside a class, preventing unauthorized parties' direct access to them.

1m – Publicly accessible methods are generally provided in the class (so-called getters/ accessors and setters/ modifiers) to access the values, and other client classes call these methods to retrieve and modify the values within the object.

OR

1m – Encapsulation is also known as information hiding because it hides specific information and control access to the internal state of the object.

1m – Attributes of a class will be hidden from other classes and can be accessed/ modified only through its accessor/ modifier methods.

(d) Applying encapsulation here (2 marks)

1m – Choose an appropriate attribute to be kept private.

1m – Must use the get/ set methods to retrieve or modify the data.

For example:

Encapsulation can be applied by making attributes such as `maxCapacity` private. For `Car`, provide a public setter for `maxCapacity` that validates input (capacity ≤ 7). For `Motorbike`, make the setter for `maxCapacity` private since it must always be 1, preventing external modification.

OR

The method `calculateFare(distance)` is public while the rates and base fee remain private within `Car` and `Motorbike` classes. Clients can compute fares, using the public method, without knowing the formula details.

3. e-Assessment Portal – Digital Signatures and Firewall (Suggested Answers)

(a) Digital signature explanation in this context (5 marks)

1m per bullet

Creating the Signature:

- Hash the spreadsheet using a cryptographic algorithm/ hash function.
- Encrypt the hash with the teacher's private key to create the digital signature.
- Upload the spreadsheet together with the signature and the teacher's certificate.

Verifying the Signature:

- Portal hashes the received spreadsheet and uses the teacher's public key (from the certificate or key registry) to decrypt the signature.
- If the decrypted hash matches the newly computed hash, authenticity and integrity are confirmed; otherwise, reject.

(b) One key difference (1 mark)

Encryption provides confidentiality (hides content). A digital signature provides authenticity/integrity (proves who signed it and that it was not altered).

(c) Firewall policy (2 marks)

Any two points, 1m each

Network Firewall:

- Allow only HTTPS traffic from the Internet to the e-Assessment portal, blocking all other types of connections.
- Restrict administrative access to specific permitted IP addresses from the IT office.
- Actively block IP addresses flagged for malicious activity and apply basic traffic controls to prevent overload.

Software (Host) Firewall:

- On the server itself, allow inbound connections only for the web service and block all other ports.

Web Application Firewall (WAF):

- Filter and inspect all web requests to block common web attacks such as injections or cross-site scripting.
- For spreadsheet uploads, accept only valid file types and sizes, scan for malware.

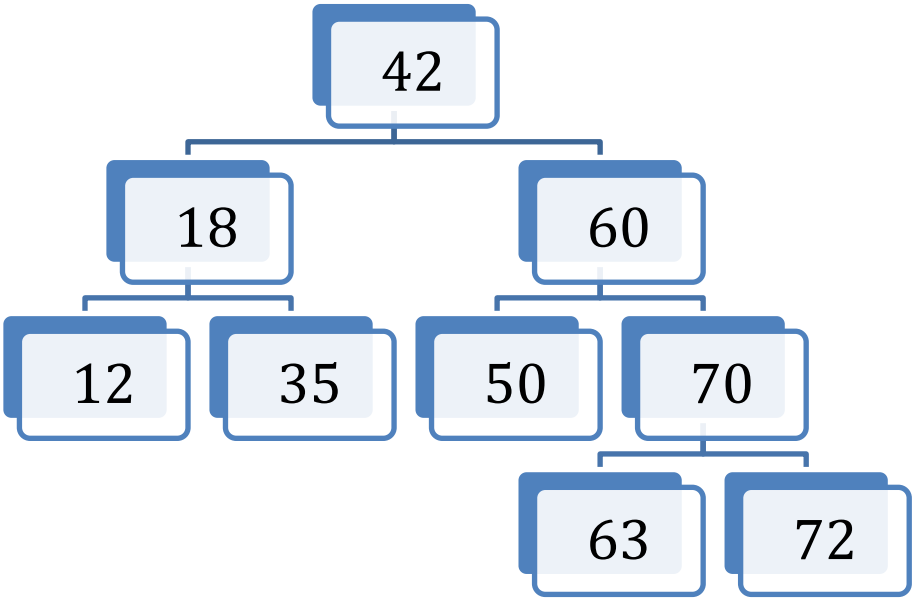
4. BST of Locker IDs + Circular Queue (Suggested Answers)

(a) Build & In-order (3 marks)

i. BST shape

1m – root

1m – rest of the nodes



ii. In-order output: 12, 18, 35, 42, 50, 60, 63, 70, 72

(b) Recursive InOrder(root) (3) no mark for wrong sequence

```
PROCEDURE InOrder(node)
    IF node <> NULL THEN //1m

        InOrder(node.left) //1m

        OUTPUT node.key //1m

        InOrder(node.right) //1m
    ENDIF
ENDPROCEDURE
```

ii. Iterative BST_Search

1m per step

1. Start at the root node and set it as the current node.
2. While the current node is not empty: (1m)
    - If the search key k is equal to the key stored in the current node, return **True** (key found).
    - If k is less than the key in the current node, use the **left pointer** (which references the left child node) to move to the left child. Otherwise, use the **right pointer** (which references the right child node) to move to the right child.
3. If the search reaches an empty node, return **False** (key not found in the tree).

(c) Worst-case time complexity (2 marks)

1m – The worst case is the BST is skewed, and the key is not found.

1m – Leading to O(n) time complexity.

(d) Why BST over a sorted linear array (2 marks)

1m – Balanced BST gives O(log n) search and supports O(log n) insert/delete.

1m – An ordered array also has O(log n) for binary search but O(n) insertion/deletion due to its contiguous nature.

Hence, BST is preferred since its allocation and deallocation of locker ids are more efficient.

(e) Circular queue pseudocode (6 marks) – capacity 50

```
FUNCTION DEQUEUE(PASS BY REF: Q, head: INT) RETURNS INT //1m
    IF head = -1 THEN //1m
        OUTPUT "QUEUE IS EMPTY"
        RETURN -1 //1m
    ENDIF


    val ← Q[head] //1m
    head ← (head + 1) MOD 50 //1m

    RETURN val //1m
ENDFUNCTION
```

(f) One advantage of a circular queue (2marks)

1m – Circular queue enables wrap around

1m -which reuses the empty space after an item has been dequeued.

5. Smart Thermostat – Static vs Dynamic Memory (Suggested Answers)

(a) Cause of the recurring problem (3 marks)

1m – A dynamic data structure is used for HISTORY, which grows continuously as a new record is added during every loop, eventually exceeding the available memory space.

1m - DISPLAY_BUFFER is initialised in each cycle, and if the previous buffer is not deallocated or reused, these abandoned buffers accumulate in memory. Over months, this can lead to excessive memory use, increased fragmentation,

(b) How to change the algorithm (2 marks)

1m – To prevent HISTORY from consuming all available memory, impose a fixed size limit or use a circular buffer so that older records are overwritten once the limit is reached

1m - For DISPLAY_BUFFER, allocate it once during initialisation and reuse the same buffer each cycle by clearing its contents, or ensure that any previous instance is properly deallocated before creating a new one. This prevents unnecessary memory growth and reduces fragmentation.

(c) One advantage and one disadvantage of dynamic allocation (2 marks)

Advantage (1m): Flexibility — memory is used only when needed, avoiding wastage from unused pre-allocated space.

Disadvantage (1m): Risk of fragmentation or memory leaks if memory is not deallocated properly, as the developer must manually manage both allocation and deallocation.

6. Intro to Networking – DNS, Packets, IP (Suggested Answers)

(a) DNS name-to-address (3 marks)

1m – The client sends a request to a DNS server, asking for the IP address that corresponds to the domain name portal.jpjc.edu.sg.

1m – The DNS server looks up this domain in its records; if it is not found, the DNS server will forward the request to another DNS server until the address is located.

1m – Once found, the IP address is returned to the client.

(b) Internet packets (6 marks)

(i)

Reason 1 (1m): Splitting data into packets allows large files or messages to be broken into smaller, manageable units that can be transmitted efficiently across different network types, avoiding problems with size limits and enabling faster delivery by sending packets along different routes.

Reason 2 (1m): If a packet is lost or corrupted during transmission, only that packet needs to be resent instead of the entire file, improving reliability and making better use of network resources.

(ii)

1m – Packets are sequentially numbered so the receiving device can reassemble them in the correct order to reconstruct the original data.

1m – Since packets may take different routes across the Internet and arrive out of sequence, numbering ensures the receiver can detect missing packets and request their retransmission if necessary.

(iii)

The source address

The destination address

(c) Static vs dynamic IP—key difference (1 mark)

Static IP is fixed and manually assigned; dynamic IP is leased automatically (e.g., via DHCP) and may change over time.

(d) Addressing choice for 300 student laptops (3 marks)

1m – I would choose dynamic addressing

1m - Students may use different devices on different days. Dynamic addressing via DHCP allows IP addresses to be assigned automatically and reused as students leave, avoiding the need to manually configure each laptop.

1m – Dynamic addressing is more secure than static addressing because IP assignments change over time, making it harder for unauthorised users to predict or reuse valid addresses.

7. PDPA – Personal Data and Controls (Suggested Answers)

(a) Define personal data + example (2 marks)

Personal data: data about an identifiable individual (alone or with other accessible information), whether true or not. Example here: NRIC, full name+mobile, bank account, or the passport-style photo.

(b) One threat and one prevention method (2 marks)

Threat: data breach leading to identity theft or financial fraud. Prevention: strong access controls and encryption (TLS in transit; encryption at rest), with MFA for admin accounts.

(c) Two PDPA controls (2 marks)

• Purpose limitation & notification/consent: collect only what is necessary and state purposes clearly.

• Protection & retention limits: implement role-based access, audit logs, secure coding; retain data only as long as needed then securely dispose.

8. Recursive Folder Listing (Suggested Answers)

(a) Base case (2 marks)
The base case occurs when the folder is either NULL (no valid folder was supplied) or when the folder is empty (isEmpty() = TRUE).

(b)
(i) Order of recursive calls (2 marks)

```
ListAll(FOLDER_A)
    ListAll(FOLDER_B)
ListAll(FOLDER_C)
    ListAll(FOLDER_D)
ListAll(FOLDER_E)
```

(ii) Sequence of file names (1 mark)

```
X.txt
Z.ppt
W.jpg
Y.txt
```

(iii) 5 times (1 mark)

(c) When stack overflow occurs (2 marks)

1 mark – A stack overflow can occur if the recursion depth becomes too large.
1 mark – For example, a very deeply nested folder chain (Root/Level 1/Level 2/.../Level N) where N exceeds the language/runtime's maximum call stack size.