YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CG		INDEX NO	

COMPUTING **9569/01**

Paper 1 Written **9 Sep 2024**

3 hours

Additional Materials: 12-page Answer booklet

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 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.**

1 When a customer inputs the amount of money he wants to withdraw from his bank account into an Automated Teller Machine (ATM), the ATM will dispense the requested amount if:

- it is not more than the account balance, and
- the customer has not exceeded the daily withdrawal limit.

The ATM will also check the amount of money in the ATM and offer the amount available if it is less than the customer's requested amount.

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

(b) Remove the redundancies from the decision table. [2]

(c) Write pseudocode for the customer to input the requested amount of money, check the account balance, check if the customer has exceeded the daily withdrawal limit and the amount of money available in the ATM. After all the checks, the ATM will output one of these messages:

- "ATM will dispense the requested" `Amt`
- "ATM can only dispense" `AmtATM`
- "Transaction cancelled"

Use the following variable names in your pseudocode:

Variable Name	Use
`Amt`	Amount of money requested
`AccBal`	Account balance
`DailyLimit`	Daily withdrawal limit
`AmtATM`	Amount of money available in ATM

[4]

2 The following function `X(n)` takes a positive integer `n` and returns an integer value.

```
def X(n):
    if n == 0:
        return 0
    else:
        return n + X(n-1)
```

(a) State 3 features of a successful recursive function. [3]

(b) Explain the significance of the line calling the function `X` with parameter `(n-1)`. [2]

(c) Explain the reason why an error message

"`maximum recursion depth exceeded`"

is raised when running this recursive function with a very large `n` value. [2]

(d) State a way to avoid the maximum recursion depth error. [1]

(e) Write the pseudocode for the function `X(n)` using the method stated in **(d)** to avoid the maximum depth recursion error. [2]

3 Insertion sort is often described as an incremental sorting algorithm, while merge sort is a divide and conquer algorithm.

(a) Describe the insertion sort algorithm. Your description should include how the algorithm processes each element, inserts it into the correct position, and sorts the list incrementally. [3]

(b) Describe the merge sort algorithm. Your description should include how the algorithm divides the data, processes the data at each step, and merges the data. [4]

The sentence *'The quick brown fox jumps over the lazy dog.'* is a pangram in the English language – it contains all the 26 letters of the alphabet in the nine words. These nine words are placed in the following list `seq`:

```
seq = ['the', 'quick', 'brown', 'fox', 'jumps', 'over', 'the',
       'lazy', 'dog']
```

(c) Show, step by step, how the elements in `seq` can be sorted in ascending order using the merge sort algorithm. Clearly indicate how the data are divided, processed, and merged during the sorting process. [3]

(d) By stating the Big-O time complexities for the insertion sort and merge sort algorithms, explain which algorithm is more efficient and under what circumstances. [2]

4 Object-Oriented Programming (OOP) is a programming paradigm that uses classes and objects to model real-world entities and their interactions, promoting modularity, reusability, and maintainability in software design.

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

(b) Explain the concept of inheritance in OOP. Use a relevant example to illustrate your explanation. [3]

(c) Describe the concept of polymorphism and discuss how it enables code generalisation. [2]

A Binary Search Tree (BST) is a data structure used to store elements in a hierarchical manner.

(d) Define a BST and explain its key properties. [3]

To implement a BST using OOP, two classes, `Node` and `BST`, are defined. The UML diagrams of the classes are provided below:

Node
- value: integer - leftPointer: Node - rightPointer: Node
+ constructor() + getValue(): integer + getLeft(): Node + getRight(): Node + setValue(new: integer) + setLeft(new: Node) + setRight(new: Node)

BST
- root: Node
+ constructor() + insert(new: integer) + search(value): Boolean + inOrderTraversal() + preOrderTraversal() + postOrderTraversal()

(e) Describe the algorithm for the method `insert()` in the `BST` class. [3]

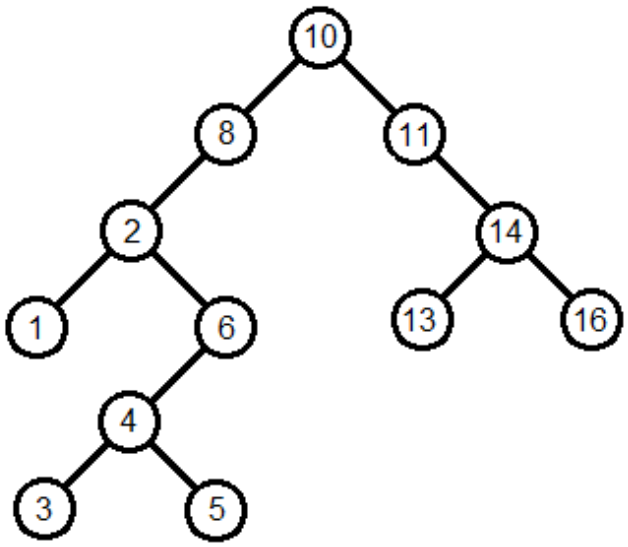
An incomplete program code for the method `search()` in the `BST` class is given below:

```
01 def search(self, value):
02     <A>
03     while current is not None:
04         if current.getValue() == value:
05             return True
06         elif current.getValue() > value:
07             <B>
08         else:
09             <C>
10     <D>
```

(f) Write the missing lines of code at **<A>**, **<B>**, **<C>**, and **<D>**.

[3]

An example of a BST is given below:



(g) For the following traversal methods, state the order of traversal and write the output when they are used for the above BST:

(i) `preOrderTraversal()` [2]

(ii) `postOrderTraversal()` [2]

5 Data can be stored in a fixed size hash table or an array.

(a) State and explain two advantages of using a fixed size hash table over an array for data storage. [4]

(b) When storing data into a fixed size hash table, the two common strategies to overcome collisions are Separate Chaining (Open Hashing) and Linear Probing (Closed Hashing).

(i) Describe how each of these strategies works. [2]

(ii) State one disadvantage of applying each of these strategies. [2]

(c) In terms of memory allocation, compare dynamic and static data structures by stating one advantage and one disadvantage of each type of data structure. [4]

6 A new company plans to establish a Local Area Network (LAN) based on a client-server architecture. The company's key priorities are to ensure robust data protection within the LAN and to implement strong security measures to prevent unauthorised access to the network.

(a) State and explain two advantages of setting up a local area network with server-client architecture. [4]

(b) State and explain two ways to prevent unauthorised remote access to the data in the file and database servers. [4]

(c) State and explain three authentication methods for accessing data within a local area network. [6]

(d) State and explain two methods of ensuring data security when transmitting across networks. [4]

7 State and explain three advantages of using NoSQL databases over relational databases. [6]

8 The tech company CyberCorp designed a software GuardOn, which was designed by the tech company CyberCorp to manage computing devices in the network for other organisations. When the ethical hacker, Alex, discovered a critical vulnerability in the software that could lead to data loss and disclosure of users' information, he promptly informed CyberCorp with detailed information about the vulnerability and a solution to address it.

Alex was concerned about the potential risk when CyberCorp did not respond after five weeks and he wrote to the company again. The management at CyberCorp replied that the vulnerability issues had been resolved but did not provide any further details.

A few weeks later, news broke out that a malicious hacker had exploited the reported vulnerability in GuardOn and caused thousands of users to lose their access to their data files and devices. The users' personal data were also found on sale on the dark web.

This incident raised serious concerns about the security of GuardOn and the legal and ethical implications of CyberCorp's actions.

(a) State and explain two ways in which Alex has adhered to the ethical principles of a computing professional. [4]

(b) State and explain two ways in which CyberCorp's failure to handle the vulnerability issues promptly breaches the ethical principles and their legal obligations. [4]

(c) List and explain four potential societal and economic consequences of this incident. [4]

END OF PAPER