HWA CHONG INSTITUTION
C2 PRELIMINARY EXAMINATION 2024

COMPUTING
Higher 2

10 Sept 2024 **Paper 1 (9569 / 01)** **1400 -- 1700 hrs**

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.

1. Validation and verification are used in data entry.

(a) (i) State the purpose of verification. [1]
(ii) State **one** method of verification. [1]

(b) The use of check digits is one validation technique.
(i) State the purpose of validation. [1]
(ii) State **one** method of validation other than check digits. [1]
(iii) Name **two** types of error that check digits usually detect. [2]

ASCII code and Unicode are two of the methods of encoding characters.

(c) The ASCII code in denary for the character '`1`' is `49`.
(i) Using 7 bits, express the ASCII code for the character '`4`' in binary. [1]
(ii) Express the character '`4`' as a hexadecimal number. [1]
(iii) Convert the hexadecimal number `4B1` to a binary number stored as two bytes. [2]

(d) (i) State the values that are common to both ASCII and Unicode. [1]
(ii) Why is Unicode preferred over ASCII in modern computing? [1]

2. (a) Describe **one** real-life application of multi-factor authentication, [1]

(b) Describe what happens when you type a URL into your web browser and press Enter. Include the role of DNS and web server in your explanation. [4]

(c) An IT company's employee Mr. K was fired from his role due to poor performance. However, due to an oversight, his access credentials were not revoked immediately. This allowed him to access the company's systems multiple times between January and March 2023.

During these unauthorized accesses, Mr. K deployed scripts he had found online to delete 180 virtual servers used for software testing. The total damage caused by this act was estimated to be around $678,000. For his actions, Mr. K was sentenced to two years and eight months in prison. Identify **two** breaches of the code of ethics committed by Mr. K as a computer professional. [2]

3. (a) Explain the need for communication protocols in a network. [1]

(b) State the **five** layers of the TCP/IP model and give a reason why layering is necessary. [2]

(c) Describe how packet switching handles network congestion. State **two** items that are stored in the packet header. [3]

(d) Describe the roles of switches and routers in a computer network. [2]

4. (a) Describe how the sender creates a digital signature and how the recipient verifies the authenticity of a digital signature. [5]

(b) Describe how a firewall protects computer networks and **one** limitation of a firewall. [2]

5. (a) State the ideal pivot for the quicksort algorithm and explain why it improves the efficiency of the algorithm. [2]

(b) The following function implements the bubble sort in Python.

```
def bubble(array):
   n = len(array)
   for i in range(n-1):
      for j in range(n-i-1):
         if array[j] > array[j+1]:
            array[j+1], array[j]= array[j], array[j+1]
```

Amend the function to improve its efficiency. Give **one** set of test data that could be used to demonstrate the improvement of efficiency in you amended function. [4]

(c) The contents of an array are shown:

47	82	16	54	91	37

Show how the array can be sorted in ascending order using insertion sort and merge sort. [5]

(d) A given data set is largely sorted. Explain why a programmer might choose to use an insertion sort rather than merge sort in this situation. [2]

6. A library management system is being developed to manage the catalogue of items available for borrowing. The library has books and DVDs in its collection.

For all library items, the data that will be stored include:
- Item ID
- Title
- Creator
- Launch Date
- Borrowed Status
- Due Date

For books, the additional data stored include:
- ISBN
- Number of Pages
- Genre

For DVDs, the additional data stored include:
- Duration (minutes)
- Age Rating

When an item is borrowed:
- Borrowed status is set to TRUE
- Due date is set to the borrowing date plus the borrowing period (e.g. 21 days).

When an item is returned:
- Borrowed status is set to FALSE
- Due date is cleared
- A fine is calculated based on the number of overdue days multiplied by the standard daily fine rate.

Object-oriented programming will be used to model library items.

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

- The superclass
- Any subclasses
- Inheritance
- Properties
- Appropriate methods [7]

(b) State the purpose of a superclass. Give an example of a superclass from the library management example. [2]

Encapsulation and polymorphism are fundamental principles of object-oriented programming.

(c) State the purpose of encapsulation. [1]

(d) Explain how data hiding is achieved in a class through encapsulation. Support your answer with examples from the library management system. [3]

(e) Define the term polymorphism. [1]

The library wants to introduce an additional charge for DVDs that varies for each DVD for each day they are overdue, in addition to the standard daily fine.

(f) Suggest a modification to the class diagram to accommodate the new charging scheme for DVDs. [2]

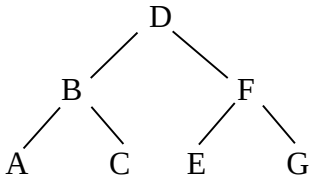
7. A binary search tree (BST) holding the first 10 prime numbers is implemented using object-oriented programming. Each node comprises three attributes: a `left` pointer, the `data` and a `right` pointer. `None` indicates there are no further nodes in a particular direction.

(a) Draw the BST given its preorder traversal: 11, 7, 3, 2, 5, 19, 13, 17, 29, 23. [3]

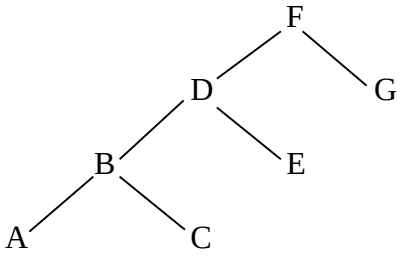
(b) Write a recursive function in **pseudocode** that takes the `root` node of a BST as a parameter and returns the number of nodes in the tree. [3]

(c) Write a recursive function in **pseudocode** that returns a list of the prime numbers in the BST in in-order sequence. [3]

A binary search tree may be *balanced* (with the left and right subtrees of about the same size) or *unbalanced* (with left and right subtrees of significantly different sizes).



Balanced tree



Unbalanced tree

(d) What is the main advantage that a balanced BST has over an unbalanced BST? [1]

(e) Outline how you would transform an unbalanced BST into a balanced BST. [4]

8. The Singapore Bird Group (SBG) conducts numerous bird censuses annually to count and record the number and species of birds in Singapore over a defined period. Volunteers will report the number and species of birds at the locations they are situated.

The following table shows the data sheet that contains the collected information:

Census Date	Census Duration	Volunteer Name	Volunteer Contact	Bird Name	Location	Bird No
20230301	0800 to 1000	John	98765432	Javan Myna	Botanic Garden	20
20230301	0800 to 1000	John	98765432	Spotted Dove	Botanic Garden	5
20230301	0800 to 1000	Keith	91234567	Javan Myna	Admiralty Park	15
20230301	0800 to 1000	Keith	91234567	House Crow	Admiralty Park	5
20230601	1600 to 1800	John	98765432	Javan Myna	Kranji Marsh	25
20230601	1600 to 1800	John	98765432	House Crow	Kranji Marsh	15
20230601	1600 to 1800	Keith	91234567	Javan Myna	Lower Pierce Res	5
20230601	1600 to 1800	Keith	91234567	Spotted Dove	Lower Pierce Res	4

(a) Describe, with example, **one** possible issue with the way the collected information is stored. [2]

(b) Normalisation is a process used when designing database tables. The above table is already in first normal form (1NF). State **two** other requirements of the table being in third normal form (3NF). [2]

SBG decides to develop a system and model it using a relational database. A database designer identified the following entities based on the data sheet given.

(c) Copy and complete the entity-relationship (E-R) diagram for the database.

[3]

A table description can be expressed as:

`TableName( Attribute1, Attribute2, Attribute3, …)`

The primary key is indicated by underlining one or more attributes. Foreign keys are indicated by using a dashed underline.

(d) Using the information given, write table descriptions for each of the tables listed below.

(i) Census [2]
(ii) Bird [1]
(iii) Volunteer [1]
(iv) CensusData [3]

Based on the table descriptions in **part (d)**,

(e) write an SQL query to output the bird name, location, bird number and volunteer name for census conducted on '20230301'. [5]

(f) write an SQL query to output location and the total number of birds for each location for the census conducted on '20230601'. [4]