**HWA CHONG INSTITUTION**
**C2 BLOCK TEST 2020**

**COMPUTING**
**Higher 2**

**30 June 2020** **Paper 1 (9569 / 01)** **0815 -- 0945 hrs**

---

**READ THESE INSTRUCTIONS FIRST**

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

Total marks for this paper is **50** marks.

---

This document consists of **4** printed pages.

1. The Human Resource department of an organization would like to develop a system using object-oriented approach to manage the information of the employees.

   One of the functions of the system is to compute the monthly pay of the full-time employees which comprise of the monthly salary and the overtime allowance.

   Due to the rapid expansion of the organization, the organization starts to employ daily-rated employee. For daily-rated employee, their monthly pay are computed based on the rate per day and the number of days worked per month.

   (a) Draw a class diagram which exhibits the following:
   - Suitable classes with appropriate properties and methods
   - Inheritance
   - Polymorphism [6]

   (b) Explain how your design in **(a)** demonstrates code reuse. [2]

   (c) Explain the term **polymorphism** and how it is applied in your design in **(a)**. [2]

2. A queue data structure is implemented using an array `Queue` and two pointers, `Head` and `Tail`. The space in array is fully utilized to perform the queue operations.

   `Queue`: 1-dimensional array with index 1 to 10

   `Head`: pointing to the index of the first item in the queue

   `Tail`: pointing to the index of the next item that is inserted

   (a) Describe an algorithm, using pseudocode, to insert a new item `NewItem` into the queue. [4]

   (b) Describe an algorithm, using pseudocode, to delete an item from the queue. [6]

   (c) Peter intends to use the pseudocode `Length ← Tail – Head` to find the length of the queue. Give an example to explain why he fails. Write down the correct pseudocode to find the length. [3]

   (d) This data structure can also be implemented using linked list. Give **one** advantage and **one** disadvantage of linked list over array implementation. [2]

3. (a) The following is an algorithm for an insertion sort procedure.

```
PROCEDURE  sort ( A,  n )
     {insertion sort the array A, items 1 to n}
     IF  n  > 1  THEN
          sort ( A,  n - 1 )
          insert ( A,  n - 1,  A[ n ] )
     ENDIF
ENDPROCEDURE


PROCEDURE  insert ( A,  i,  X )
     {the array A has items 1 to i already sorted;
     insert the item X into position to make items 1
     to i + 1 sorted}
     IF  i  =  0  THEN
          A[ 1 ]  ←  X
     ELSE
          IF  X  >  A[ i ]  THEN
               A[ i + 1 ] ←  X
          ELSE
               A[ i + 1 ] ←  A[ i ]
               insert ( A,  i - 1,  X )
          ENDIF
     ENDIF
ENDPROCEDURE
```

Illustrate the operation of procedure **insert** ( A, 4, X ) where

A[ 1 ] is 'Amy'

A[ 2 ] is 'Ben'

A[ 3 ] is 'Ken'

A[ 4 ] is 'Tim' and

X is 'Jin'

by completing the trace table given below.

| | A[1] | A[2] | A[3] | A[4] | A[5] | i | X |
|---|---|---|---|---|---|---|---|
| **insert**(A,4,'Jin') | Amy | Ben | Ken | Tim | | 4 | Jin |
| **insert**(A,3,'Jin') | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

[4]

(b) Write an algorithm, in pseudocode, for a **non-recursive** version of the insertion sort to sort items held in an array in ascending order. [6]

(c) Identify **two** features of the array that would have an impact on the performance of this insertion sort algorithm in **(b)**. [2]

(d) State the time complexity of the sort algorithm in **(b)** if items in the array are initially in

(i) reverse order [1]

(ii) sorted order [1]

What is the maximum number of comparisons needed to sort an array of N items? [1]

4. A mall operator operates 4 malls in Singapore. Due to the recent outbreak, the mall operator decides to develop a centralized system to accurately limit the number of people entering in its premises to prevent overcrowding.

In each mall, there will only be one entrance and one exit. There is a sensor at the entrance to capture the timestamp when a person enters the mall. At the exit, there is also one sensor to capture the timestamp when a person exits the mall.

(a) The mall operator wants to model this system using a relational database.

(i) A database needs a number of tables to store the data for this system.
Draw the Entity-Relationship (E-R) diagram to show the tables in third normal form (3NF) and their relationships between them. [4]

(ii) 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.

Using the information given, write table descriptions for the tables you identified in **(a) (i)**. [4]

(b) State **two** reasons why the mall operator may wish to choose a NoSQL database. [2]

**--- END OF PAPER ---**