HWA CHONG INSTITUTION
C2 PRELIMINARY EXAMINATION 2021

COMPUTING
Higher 2

1 September 2021 **Paper 1 (9569 / 01)** **0815 -- 1115 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 **8** printed pages.

1 An E-Commerce company stores the following data of customers in the system.

- Name
- Contact
- Address

It categories its customers into 2 types of loyalty programs.

- Spend-based loyalty program
- Paid loyalty program

Customers of Spend-based loyalty program earn one point for every block of $10 spent in a single order, whereas customers of Paid loyalty program pay a monthly or annual fee. Customers of Paid loyalty program will enjoy the benefits of having early access to sales events and free delivery for purchases above $30.

For Spend-based loyalty program, the additional data stored include:

- Points earned

For Paid loyalty program, the additional data stored include:

- Payment schedule (monthly or annually) and corresponding fee
- Next payment date, computed based on payment schedule and the date of enrollment to the program

Object-oriented programming will be used to model the customers.

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

- the superclass
- any subclasses
- inheritance
- properties
- appropriate methods [6]

The company makes changes to the Paid loyalty program to allow the customer in the program to earn ten points for every block of $20 spent in a single order, in addition to the current benefits. The points earned do not expire. For Spend-based loyalty program, all points earned will expire on the anniversary of the date of enrolment to the program.

(b) Suggest changes required to the class diagram to enable the changes. [3]

(c) Explain why inheritance is an important feature of object-oriented programming. [1]

To attract customers to enrol to its Paid loyalty program, the company launches an invitation campaign to invite Spend-based loyalty program customers who qualified the following conditions:

- Customer who earned more than 2000 points in a year and has an average of at least one order per month will be contacted by staff.
- Customer who has enrolled for at least a year and has an average of at least one order per month will be sent an invitation email.
- Otherwise, no invitation will be sent.

(d) Create a decision table showing all the possible outcomes and results. [4]

(e) Simplify your decision table by removing redundancies. [2]

2 Merge Sort is a Divide and Conquer algorithm. It divides the unsorted array `A[low..high]` into two halves, calls itself for the two halves, until each half is of length 1. It then merges the two sorted halves. An algorithm for Merge Sort is given below.

```
PROCEDURE MergeSort(A, low, high)
     IF low < high
          mid ← (low + high) DIV 2
          MergeSort(A, low, mid)
          MergeSort(A, mid+1, high)
          Merge(A, low, mid, high)
     ENDIF
ENDPROCEDURE
```

(a) Write in **pseudocode**, an algorithm for the merge procedure, `Merge(A, low, mid, high)` that is called by the `MergeSort` algorithm.

The merge procedure should merge the sorted subarrays in `A[low..mid]` and `A[mid+1..high]` into a single sorted subarray in `A[low..high]`. [6]

(b) Give and justify the time complexity of Merge Sort. [2]

3 An abstract Data Type (ADT) consists of both data type and associated operations.

A stack ADT has the following operations defined:

(i) Create(S) --- creates an empty stack S,
(ii) Insert(S, Item) --- inserts new value, Item, onto stack S,
(iii) Retrieve(S) --- removes and returns item from the stack S,
(iv) EmptyStack(S) --- returns true if stack S is empty.

(a) Devise an algorithm that converts a non-negative integer from decimal to hexadecimal, by making use of the stack operations given above. [4]

(b) Three items, L1, L2 and L3, are to be inserted into a stack in its original order, but the output would be in the order of L1, L3 and L2.

Write an algorithm, using the operations given above, that would use a stack R to carry this out. [4]

4 Some algorithms can be written using recursion.

(a) State **two** features of recursion. [2]

(b) Explain the use of a stack when the recursive procedure executes. [3]

(c) Write a recursive function using **pseudocode** that returns the sum of the digits in an integer. For example, the sum of the digits of the integer `12345` is `5+4+3+2+1=15`. [4]

5 **(a)** Vaccination centres are located across the island to facilitate the national vaccination programme. At each vaccination centre, data is uploaded to the central system of Ministry of Health.

(i) State the name of this network structure. Describe **one** disadvantage and suggest **one** method to resolve it. [3]

(ii) Describe **two** rules of conduct for the staff handling data. [2]

(b) Explain each of the following terms and how it works:

(i) Digital signature [7]
(ii) Transmission Control Protocol [3]
(iii) Domain Name System [2]

6 Check digit is one technique of data validation.

(i) Give **two** other techniques of data validation. [2]

(ii) With **one** example of data verification, explain the difference between data verification and data validation. [3]

A student ID consists of 5 digits and a check digit.

(iii) One way to calculate the check digit is to use the unit's digit of the sum of all 5 digits. For example, suppose the 5 digits are 50879. Since 5 + 0 + 8 + 7 + 9 = 29, the check digit is 9, and the student ID is 508799.

Explain, with **two** examples, why this method is inadequate. [2]

The check digit is calculated from the 5 digits using the modulus 11 system. It can be digits `0 - 9` or character `'X'`.

(iv) Showing your working, determine the check digit for 30526. [3]

(v) Write an algorithm to check if a student ID is valid. [5]

(vi) A function is designed to read a student ID and determine if it is valid. State the data types of its input parameter and justify. [2]

7 **(a)** **(i)** What is a flowchart? [1]

(ii) Draw a flowchart to find the factorial of a given positive integer `N`. [2]

(b) You have a row of `2n` disks of two colors, `n` black and `n` white. They alternate: black, white, black, white, and so on. You want to get all the black disks to the right-hand end, and all the white disks to the left-hand end. The only moves you are allowed to make are those that interchange the positions of two neighboring disks.

Assume that there is an array `A` of size `2n` representing the alternating disks. Write, in **pseudocode**, an algorithm to solve this puzzle and determine the number of moves it takes. [5]

8 The school is designing a website to allow ordering of meal. The database stores data about

- students
- meal information
- order information

An order contains one meal only.

Each meal can be purchased by different students.

A student never places more than one meal on any day.

The data is stored in a relational database.

A first attempt of the database design produced the following single table ORDER.

Table: ORDER

Student ID	Student Name	Class ID	Class Name	OrderDate	Meal ID	MealDescription	Price
67	John	55	21S66	15-04-2021	16	Chicken rice with orange juice	4.00
				21-04-2021	23	Japanese Bento with green tea	5.00
				13-05-2021	30	Fried Mee with apple juice	4.00
54	Peter	57	21S67	18-04-2021	32	Fried rice with orange juice	4.00
				25-04-2021	30	Fried Mee with apple juice	4.00
32	Mary	59	21S69	16-04-2021	23	Japanese Bento with green tea	5.00
				30-04-2021	5	Big burger meal set	5.00
				15-05-2021	16	Chicken rice with orange juice	4.00
73	Jean	62	21S68	18-04-2021	23	Japanese Bento with green tea	5.00
				28-04-2021	16	Chicken rice with orange juice	4.00
				14-05-2021	23	Japanese Bento with green tea	5.00

(a) Explain why the table is not in first normal form (1NF). [1]

The following is an attempt to reduce data redundancy:

Table: Student

StudentID	StudentName	ClassID	ClassName
67	John	55	21S66
54	Peter	57	21S67
32	Mary	59	21S69
73	Jean	62	21S68

Table: Meal

MealID	MealDescription	Price
16	Chicken rice with orange juice	4.00
23	Japanese Bento with green tea	5.00
30	Fried Mee with apple juice	4.00
32	Fried rice with orange juice	4.00
5	Big burger meal set	5.00

Table: Order

StudentID	MealID	OrderDate
67	16	15-04-2021
67	23	21-04-2021
67	30	13-05-2021
54	32	18-04-2021
54	30	25-04-2021
32	23	16-04-2021
32	5	30-04-2021
32	16	15-05-2021
73	23	18-04-2021
73	16	28-04-2021
73	23	14-05-2021

(b) State suitable primary key(s) for each table. [3]

(c) Explain the reasons for reducing data redundancy in a relational database. [2]

(d) Draw an entity-relationship (E-R) diagram showing the degree of the relations. [2]

(e) State which table is not in third normal form (3NF) and explain why. [2]

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.

(f) Write table descriptions for the required tables in the databases so they are in third normal form (3NF). [4]

(g) Write an SQL query to output the student names and date of order of all the orders for the meal "`Japanese Bento with green tea`". [3]