Name:_____ **Class:**_____

JURONG PIONEER JUNIOR COLLEGE

2022 JC2 Preliminary Examination

COMPUTING **9569/01**
Higher 2
19 September 2022

Paper 1 (Written) **3 hours**

Additional materials: Answer Papers
Cover Page

READ THESE INSTRUCTIONS FIRST

Answer **all** the questions.

Approved calculators are allowed.
You are reminded of the need for clear presentation in your answers.

Answer papers will be provided with the question paper.
Write your name and civics class on all the work that you hand in.
Write in **dark blue** or **black pen** on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Write your answers to every question **on a fresh page of paper**.

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 J House is a luxury co-living operator situated in Singapore's Central Business District (CBD) that leases its suite of bedroom apartment units to its tenants on a long term basis. In co-living spaces, tenants rent the type of bedroom apartment unit they prefer, and share the use of common facilities like the kitchen, work area, etc with the other tenants.

With the rental market heating up, it is observed that there has been an increasing number of people gravitating towards renting a place from co-living businesses like J House. This allows tenants to pay a lower monthly rental, yet at the same time, benefit from the convenience of living in a location that is near or within the CBD.

J House registers and keeps a record of all its tenants, past and present. The National Registration Identity Card (NRIC) numbers, or the Foreign Identification Number (FIN) are collected and used to uniquely identify a tenant.

The Personal Data Protection Commission (PDPC) updated its advisory guideline on the Personal Data Protection Act with regard to collecting, using and disclosing of NRIC and other National Identification Numbers of individuals.

(a) **(i)** What is data integrity? [1]

(ii) State **two** threats that reduce the integrity of data. [2]

(iii) Explain the difference between data integrity and data security. [2]

(iv) Why is there a need to have archive files? [1]

(b) What is data validation and explain why it is not the same as data security? [2]

Identification numbers of individuals like the NRIC, and FIN are considered to be sensitive personal data of an individual.

(c) Explain how indiscriminate or negligent handling of the NRIC or FIN can impact an individual. [2]

(d) Name **two** approaches that J House can implement and practise in order to better protect the information of its tenants. [2]

Instead of collecting the NRIC or FIN of tenants, the management of J House has decided to generate `tenantID`, that is made up of **eight** alphanumeric characters to uniquely identify every tenant registered. The leftmost **four** characters of `tenantID` are obtained by concatenating the date and month of the tenant's birthday in *ddmm* format, followed by **three** characters obtained by using the rightmost NRIC or FIN number of the tenant, and the **one** rightmost character of `tenantID` will be used as its check digit. For instance, an individual borned on 1 November 1988 (ie. `01111998` in `ddmmyyyy`), with NRIC "`S1234567B`" will have the following eight alphanumeric characters `tenantID`:

Birthday in *ddmm*				**NRIC three rightmost integers**			**Check Digit**	
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**digit position**
0	1	1	1	5	6	7	**?**	`tenantID` **(8 alphanumeric characters)**

The validity of a `tenantID` is determined by its check digit. Given that the check digit is obtained using the following rule:

1. With exception of the check digit, multiply each digit in `tenantID` with its corresponding digit position.
2. Sum up the results of the multiplications obtained in step (1).
3. Divide the product sum from step (2) by 11 to get the remainder.
4. Subtract the remainder obtained in step (3) from 11,
5. Obtain check digit as the remainder of dividing the result in step (4) by 11.

By applying the rules above, the check digit of the `tenantID` given above is **7**.

(e) With workings shown clearly, find the check digits of the following tenants that have the following details:

(i) Tenant A: `Birthday = '01 February 1987'`, `NRIC = 'S8765432D'`, [2]

(ii) Tenant B: `Birthday ='17 December 1980'`, `NRIC = 'S8021896C'`. [3]

(f) Validate `tenantID` that contains the value '`09089953`'. [2]

The management of J House saw the potential of technology and wishes to develop a computerised integrated data management system that has the ability to store and manage information related to the:

- tenants,
- bedroom apartment units, and
- rental records.

A database management system (DBMS) will be used in the development of the computerised integrated data management system.

- Each tenant is uniquely identified by his or her `tenantID`.
- A unique `apartmentID` field will be assigned to every bedroom apartment unit. `apartmentID` is preceded by '#', followed by two leftmost digits that refer to the floor level which the unit is located, a hyphen sign, and some numbers after the hyphen sign refer to the allotted number for that particular unit.

(g) Explain the role and purpose of

(i) a primary key, [2]

(ii) a foreign key. [2]

A rental module for booking a bedroom apartment unit will also be developed as a part of the computerised integrated data management system for tenants to make reservations digitally.

- The system has implemented adequate validation and **will not** allow any bedroom apartment unit to be double booked.
- A rental contract record will be created when a tenant has successfully booked a bedroom apartment unit through the system.
- A rental contract record serves as an agreement made on the date of booking, reference **one** tenant to **one** bedroom apartment unit, over a specified duration.
- For instance, one tenant who successfully books three different bedroom apartment units will result in the creation of three different rental contract records.
- A tenant is allowed to rent **one or more** bedroom apartment units as long as there is no double booking on any of the bedroom apartment units.
- Any details relevant to tenants and bedroom apartment units will also be captured.

(h) A table description can be expressed as:

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

The primary key is indicated by underlining one or more attributes.

By including all attributes given in the data model above, write down the fully normalised table descriptions for the tables,

(i) **Tenant**, and **Apartment**, suggesting **two** more attributes that are most appropriate to each table. [2]

(ii) **RentalContract**, given that the system will not generate any additional unique key to differentiate records in **RentalContract**. [1]

(i) Draw an entity-relationship (ER) diagram showing the necessary **three** tables and the relationships between them. [3]

(j) Explain how foreign keys can be used to implement one-to-many relationships between the entities in the E-R diagram obtained in **(i)**. [2]

(k) Explain how data redundancy is different from data inconsistency in this context. [2]

(l) Describe how data redundancy when left unresolved will result in update anomalies, and eventually lead to inconsistent data. [2]

2 A linked list is an an Abstract Data Type (ADT) that consists of a sequence of items in linear order that are connected to each other. It can be defined as:

- each item in the linked list is called a node,
- each node contains a `data` field that holds the actual data, and a `next` pointer field that contains the address of its successor node,
- `start` is an attribute of the linked list that stores the address of the first linked list node, and
- the pointer field of last node in the linked list stores a `NULL` value.

(a) **(i)** Explain why arrays are inefficient at executing insertion and deletion of data items. [3]

(ii) Explain why linked list can address the short-comings of arrays mentioned in **a(i).** [1]

(b) Describe an algorithm that inserts a new node to the front of a linked list. [3]

(c) With the use of diagrams, explain the process of deleting the rear node of a non-empty linked list. [3]

(d) State **one** disadvantage of a linked list. [1]

(e) Using the linked list implementation above, write pseudocode for function `find(k)` that returns `True` when `k` is found stored as a data item in the link list, or `False` if otherwise. [3]

The following are operations of a ADT linked list implemented by a collection of nodes where each node has an item `data`, and a pointer to the next item in the linked list, and a head pointer `start` which points to the first item in the list:

(i) `Create(x)` – creates an empty linked list `x` with pointer `start = 0`.

(ii) `Insert(x,data,i)` – inserts `data` as a new item in linked list `x` at position `i`.

(iii) `Delete(x,i)` – deletes the item at position `i` in linked list `x`.

(iv) `Read(x,i)` – returns the item at position `i` in linked list `x`.

(v) `Length(x)` – returns the current total number of items stored in linked list `x`.

(vi) `IsEmpty(x)` – returns `True` if linked list `x` is empty, otherwise `False`.

(f) Use the operations of the ADT linked list given above to implement the following operations of a queue ADT in pseudocode:

(i) create a new queue `Q`, [1]

(ii) enqueue a data item `data` into `Q`, [1]

(iii) dequeue a data item from `Q`. [3]

3 Quick-sort is a sorting algorithm that divides the array into two parts and sorts each part recursively. Given that the first element of the array will be chosen as the pivot element at each recursion.

(a) Describe the operations of the above quick-sort algorithm when applied to sort an array of integers in ascending order. [4]

(b) State the best case time complexity of the quick-sort algorithm. [1]

(c) Describe a scenario that will result in worst case time complexity for the quick-sort algorithm used in this question. [2]

4 The pseudocode of procedure X is given as:

```
1. PROCEDURE X(n : INTEGER)
2.     IF n = 0 OR n = 1 THEN
3.         PRINT(n)
4.     ELSE:
5.         X(n DIV 2) // DIV returns quotient of n/2
6.         PRINT(n MOD 2) // MOD returns remainder of n/2
7.     ENDIF
8. END PROCEDURE
```

(a) State the **three** basic programming constructs. [2]

(b) Name the programming constructs used in X? [2]

(c) Suggest **one** way to improve the readability of X. [1]

(d) State the line number that identifies X as recursive. [1]

(e) Dry run the procedure call `X(36)` from the main program showing all the subsequent recursive calls and its corresponding parameter values, together with the final printed output. [4]

(f) What is the purpose of procedure X? [1]

5 Greenhorse Express is a travel transportation company that provides two-way transportation services to passengers between Singapore and Genting Highlands.

The fleet of vehicles owned by Greenhorse Express to ferry passengers can be categorised as either a bus or minivan. All vehicles are identified by their vehicle registration number, and its maximum passenger capacity. The maximum passenger capacity of a bus is determined by the sum of its maximum seating capacity, and its maximum standing capacity. On the other hand, the maximum passenger capacity of a minivan is just its maximum seating capacity as standing is not allowed.

Also, the traffic law requires minivan owners to ensure that all passenger seats to be upgraded and equipped with seat belts. As such, owners of the minivans are expected to keep track of the total number of minivans that are not fully equipped with seat belts, so that they can work towards completing this upgrade.The minivans owned by Greenhorse Express are still in the midst of installation, and there is a need to keep track of this number.

As nations recover and reopen after the pandemic, the sharp spike in the number of passengers has made Greenhorse Express to engage an IT company to use object-oriented programming to computerise their work processes.

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

(b) Draw a class diagram that describes all the mentioned attributes of the fleet of vehicles owned by Greenhorse Express. [4]

(c) Use the class diagram obtained in **(b)** to explain the term inheritance. [2]

6 In conventional mathematics, arithmetic expressions are represented in the form of infix notation. In postfix notation, operators are placed at the back of the operands rather than in the middle. For example, the infix expression `(1+2)` can be expressed in postfix expression as "`12+`".

Expressions can be keyed into a basic scientific calculator that has the capability of reading and evaluating fully-parenthesised infix expression with positive-integer-only operands `a`, `b`, `c`, `d`, and `e`.

A binary expression tree `T` can represent an infix form of an algebraic expression that is given to be `(a – b) * c + (d – e)`.

(a) Draw binary expression tree `T` representing the algebraic expression. [3]

The postfix notation of an algebraic expression does not require the use of parenthesis.

(b) Write down the postfix notation of `(6 – 2) * 8 + (3 – 1)`. [1]

(c) Using suitable diagrams, describe in details the steps taken to evaluate the result of the postfix notation obtained in **(b)**. [3]

7 The Domain Name System (DNS) maps IP addresses to hosts connected to either the public or private internet via a process called DNS resolution.

Describe the process of DNS name resolution, starting from the point where the user keys and sends the URL of the website to visit through the address bar of the web browser application till the point the website gets loaded on the web browser. [5]

8 **(a)** Describe the goals of network security. [3]

(b) Explain why data sharing through P2P network carries risks. [2]

(c) What is a firewall and explain how it protects a network? [3]

END OF PAPER