NANYANG JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATIONS

Higher 2

COMPUTING 9569/01

Paper 1 Written **14th September 2023**

3 hours

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.

[Turn over

1 A company wants to use Object-Oriented Programming (OOP) to write a program to track rental of audio-visual (AV) equipment. The AV equipment available for rental are:

- photography equipment (such as cameras and video cameras)
- audio equipment (such as microphones and mixers).

For all the equipment rental, the following data will be recorded:

- Model number
- Quantity
- Rental cost per day
- Number of days rented.

For photography equipment rental, the additional data recorded include:

- Storage device included (True/False)
- Tripod included (True/False).

For audio equipment rental, the additional data recorded include:

- Name of the AV technician assigned
- Venue for the set up of the audio equipment.

The cost of the equipment rental is calculated using the number of days multiplied by the rental cost per day.

(a) Draw a class diagram for the described situation, showing:
- any derived classes and inheritance from the base class
- the properties needed in the base and any derived classes
- suitable methods, in each class, to support the system. [8]

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

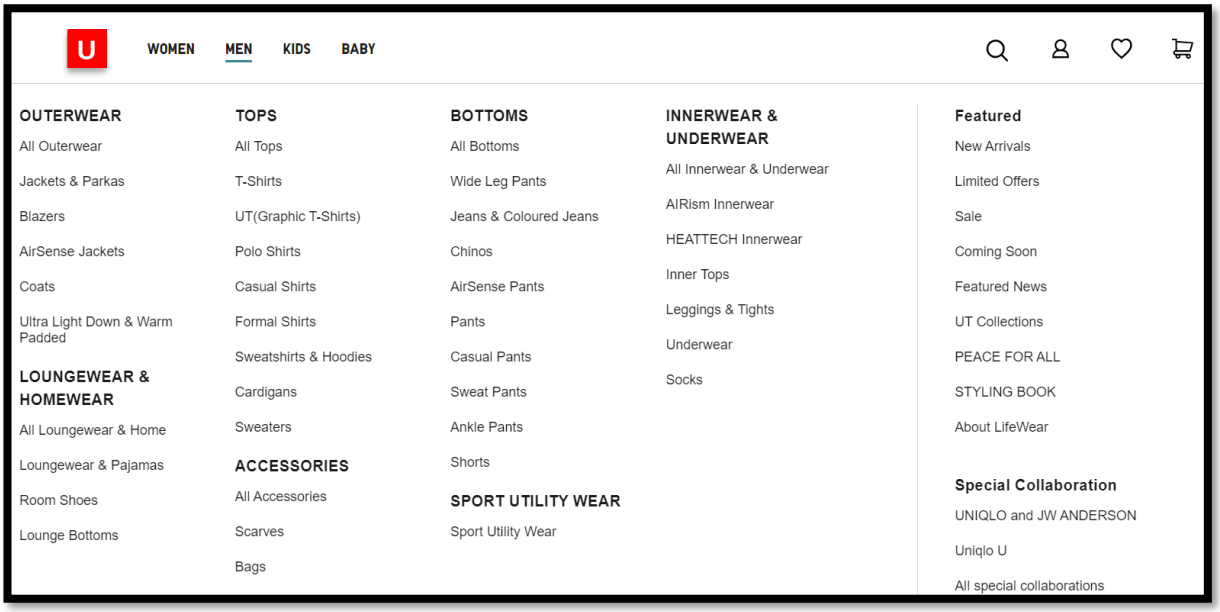
(c) State the purpose of encapsulation. [2]

The company wants to change the way the rental price for photography equipment is calculated, so that it depends on whether a photographer is required.

(d) Describe the changes to the class diagram that are required to enable the new calculation of rental price for photography equipment. [2]

(e) Explain the purpose of polymorphism. [2]

2 A fashion e-commerce company has created a website for retailers and home-based businesses to sell their products on its website. The following is a snapshot of the website's navigation links for men's clothing.



(a) State one usability principle that is implemented in the design of the navigation links and describe how it enhances the user experience. [2]

The e-commerce website has an inventory module that manages the inventory levels of the products. One of its functions is to handle inventory updates when products are sold.

(b) The algorithm for the above function is as follows:

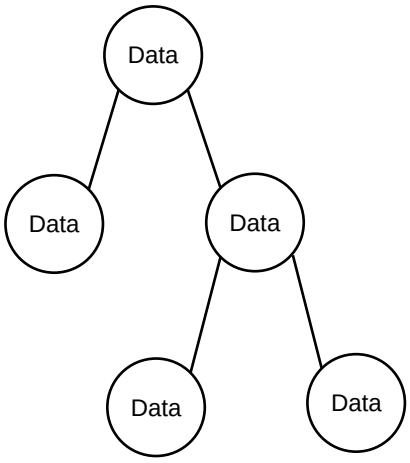
1. Retrieve the current inventory level of the product
2. Prompt the user to enter the quantity of products sold
3. Subtract the quantity of products sold from the current inventory level
4. Update the inventory level in the database with the new value
5. Display a success message confirming the inventory update.

The algorithm was found to cause some inventory levels to be inaccurately updated after products are sold.

(i) Explain how a mistake in the algorithm could be causing the reported inventory level update issues. [3]

(ii) Describe how the algorithm should be modified to address the issue and ensure accurate inventory level updates after product sales. [2]

3 A binary search tree (BST) can be represented diagrammatically, with nodes displayed as circles containing data, and pointers between nodes displayed as lines:



(a) (i) The following items are inserted into a BST in the order given, sorted alphabetically:

Melon, Guava, Apple, Lemon, Olive, Peach, Prune, Papaw, Mango

Draw the resulting BST diagram. [4]

(ii) State the result of in-order traversal of the BST from **(a)(i)**. [1]

To count occurrences of items, a BST or a hash table could be used. With a BST, each node holds the item name and the number of occurrences. With a hash table, each key-value pair comprises the item name as the key and the number of occurrences as the value.

(b) The items from **(a)(i)** are inserted in the same order into a hash table of size 10 using the following hashing function:

```
FUNCTION hash(item : STRING, size : INTEGER) RETURNS INTEGER
    // The length() function returns the number of characters in
       a string
    table_index ← length(item) MOD size
    RETURN table_index
ENDFUNCTION
```

If a key collision occurs, the next available index is used to store the data.

(i) Copy and complete the following hash table. [2]

Index	Key	Value
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

(ii) Explain how more than ten entries would be stored in the hash table. [2]

(c) (i) State the time complexity of the following operations:

1. BST search using a given key [1]

2. Hash table lookup using a given key. [1]

(ii) Explain whether a BST or hash table is more appropriate for counting a large variety of fruits. [2]

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

The following pseudo-code provides an implementation of an iterative algorithm to convert non-negative denary values to binary values:

```
01 FUNCTION denary_to_binary(denary_value : INTEGER) RETURNS STRING
02     IF denary_value = 0 THEN
03         RETURN '0'
04     ENDIF
05     binary_string ← ''
06     WHILE denary_value > 0 DO
07         // The MOD operator carries out modulus division, returning
              the remainder
08         remainder ← STRING(denary_value MOD 22)
09         // The CONCAT function concatenates two strings
10     binary_string ← CONCAT(remainder, binary_string)
11     ENDWHILE
12     RETURN binary_string
13 ENDFUNCTION
```

The `STRING` function used on line 8 is defined as follows:

```
FUNCTION STRING(value : INTEGER) RETURNS STRING
```

(b) **(i)** State the error that will occur when the above function is called with the denary value `9` as input. [1]

(ii) Explain why such an error will occur. [2]

(iii) Amend the pseudo-code such that the above function will work as intended. [1]

(iv) Copy and complete the following trace table for the function call `denary_to_binary(9)`, with the amendment from **(iii)** applied. [4]

denary_value	**binary_string**	**remainder**

(v) Using pseudo-code write a function that correctly implements the above algorithm recursively, using `denary_to_binary_recursive` as the identifier of the function. [3]

(vi) Draw the recursive trace diagram to show the chain of calls and their return values when the function in **(v)** is applied to convert the denary value `9` to its binary representation. [4]

5 MyJobPortal operates a platform that matches skilled candidates to suitable employers. Potential candidates and employers register a profile on the platform. Candidates state their qualifications and skills, while employers state their job description, requirements, and remuneration.

For each of the following data privacy obligations, describe the obligation and explain a network security feature that MyJobPortal should implement to meet the obligation.

(a) Purpose Limitation Obligation. [4]

(b) Protection Obligation. [4]

(c) Data Breach Notification Obligation. [3]

6 A company has multiple computers and printers on a local area network (LAN). The company's main router is connected to a wide area network (WAN).

(a) **(i)** State the difference between a LAN and a WAN. [2]

(ii) Explain why data transmitted between the computers and printers is divided into packets. [2]

(b) The company's network printers use the Internet Printing Protocol (IPP) which communicates using Transmission Control Protocol (TCP) on port 631.

(i) Name the layer at which computers on the network are identified. [1]

(ii) Name the layer at which the IPP is involved. [1]

(c) **(i)** Name one suitable validation technique for each of the following information:

1. Port number [1]

2. IP address. [1]

(ii) State the data verification technique used in TCP, and explain why it is necessary. [2]

7 A clinic is staffed by doctors with various qualifications and is visited by several patients. The patients are charged a basic consultation fee for each visit.

- Each patient has an ID number and a name.
- Each patient is only allowed to have one appointment per day.
- Each patient's appointment data and time is recorded.
- Each doctor can only see one patient for a given appointment.
- Each qualification has an ID, type and associated consultation fee.

The table below shows data on patient visits and the doctors who attended to them:

- Patient ID – an ID to uniquely identify each patient
- Patient Name – the name of the patient
- Patient Contact – the patient's contact number
- Appt Date – appointment date, the date of the patient's visit
- Appt Time – appointment time, the time of the patient's visit
- Doctor ID – an ID to uniquely identify each doctor
- Doctor Name – the name of the attending doctor
- Qual ID – an ID to uniquely identify each doctor's qualification
- Qual Type – the type of qualification possessed by each doctor
- Consult Fee – the consultation fee charged by each doctor.

Patient ID	Patient Name	Patient Contact	Appt Date	Appt Time	Doctor ID	Doctor Name	Qual ID	Qual Type	Consult Fee ($)
1	Robert	97654212	10/6/2023	10.00 am	101	Agatha	1	Dietician	40
2	Jones	98765432	10/6/2023	12.30 pm	216	Brenda	2	General Practitioner	50
3	Harry	95217623	10/6/2023	12.30 pm	305	Mark	3	Family Physician	70
4	Charlie	96734518	11/6/2023	8.45 am	411	Anthony	2	General Practitioner	50
5	Mary	97263511	11/6/2023	10.30 am	305	Mark	3	Family Physician	70
2	Jones	98765432	12/6/2023	8.30 am	523	Greta	3	Family Physician	70
1	Robert	97654212	12/6/2023	10.00 am	411	Anthony	7	General Practitioner	50
2	Jones	98765432	13/6/2023	11.30 am	305	Mark	3	Family Physician	70
6	Larry	89273121	13/6/2023	1.00 pm	411	Anthony	2	General Practitioner	50
1	Robert	97654212	16/6/2023	12.00 pm	101	Agatha	1	Dietician	40
7	Leena	90012121	16/6/2023	12.30 pm	523	Greta	3	Family Physician	70
5	Mary	97263511	16/6/2023	2.00 pm	523	Greta	3	Family Physician	70

(a) Explain, giving an example, whether the table above is in first normal form (1NF). [2]

To reduce data redundancy, the clinic was advised to store their data in a relational database instead.

The following tables demonstrate their first attempt.

Patient

Patient ID	Patient Name	Contact Number
1	Robert	97654212
2	Jones	98765432
3	Harry	95217623
4	Charlie	96734518
5	Mary	97263511
6	Larry	89273121
7	Leena	90012121

Doctor

Doctor ID	Doctor Name	Qual ID	Qual Type	Consult Fee ($)
101	Agatha	1	Dietician	40
216	Brenda	2	General Practitioner	50
305	Mark	3	Family Physician	70
411	Anthony	2	General Practitioner	50
523	Greta	3	Family Physician	70

Appointment

Appt Date	Appt Time	Doctor ID	Patient ID
10/6/2023	10.00 am	101	1
10/6/2023	12.00 pm	216	2
10/6/2023	1.30 pm	305	3
11/6/2023	8.45 am	411	4
11/6/2023	10.30 am	305	5
12/6/2023	8.30 am	523	2
12/6/2023	10.00 am	411	1
13/6/2023	11.30 am	305	2
13/6/2023	1.00 pm	411	6
16/6/2023	12.00 pm	101	1
16/6/2023	12.30 pm	523	7
16/6/2023	2.00 pm	523	5

(b) Explain the advantage of reducing data redundancy in a relational database. [2]

(c) **(i)** Explain why the table **Doctor** is not in third normal form (3NF). [2]

(ii) The doctor with ID 216 has recently been allocated a new ID 206.

Explain how this update could cause problems with the existing data stored. [2]

(d) A table description can be expressed as:

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

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

Write table descriptions for two tables to hold the data from the **Doctor** table, each of which are in third normal form (3NF). [4]

(e) State the primary key for the table **Appointment**. [1]

(f) Draw an entity-relationship (ER) diagram to show the necessary tables in third normal form (3NF) and the relationships between them. [3]

The clinic is concerned that many patients make appointments but do not keep them.

(g) Explain the changes that need to be made to the existing table design to store information on whether appointments have been attended. [2]

(h) Write an SQL query to output the name, qualification type and consultation fee of the doctors who attended to the patient "`Robert`", in descending order of **Consult Fee**. [7]

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