NANYANG JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATIONS

Higher 2

COMPUTING 9569/01

Paper 1 Written **13th September 2021**

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.

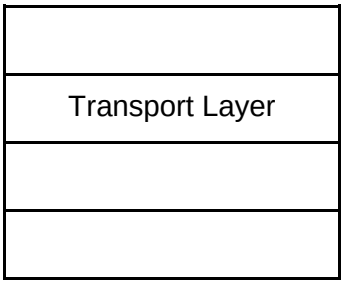
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

This document consists of **6** printed pages.

[Turn over

1 **(a)** The TCP/IP networking model comprises 4 layers.

(i) Copy and complete the below diagram for the TCP/IP stack.



[3]

(ii) State the purpose of the Transport Layer in the TCP/IP network model. [2]

(iii) State the reserved port range used in the Transport Layer. [1]

(b) A certain port number in binary form is `00000100 00011000`.

(i) Express this value in denary (decimal) form. [3]

(ii) Explain how it may be checked if this binary port value is within the reserved port range, without converting it to decimal. [2]

(c) **(i)** State which layer of the TCP/IP model the Domain Name System (DNS) protocol belongs to. [1]

(ii) Describe the purpose of the DNS protocol. [2]

2 **(a)** Validation and verification are used in data entry.

(i) State the purpose of validation. [1]

(ii) State the purpose of verification. [1]

A network program using TCP needs to check if a port number is within an acceptable range of values.

(b) Is this fulfilled by validation or verification? Explain your answer. [2]

(c) Provide three sets of suitable test values for the above check. [3]

3 A printing shop needs to set up a print queue system to serve its customers. This print queue will manage print tasks, by sending them one at a time to available printers.

For all print tasks, the data that will be stored include:

User
Printer address
Job name
Status

The print queue itself stores the following data:

Number of jobs

When a print task is added to the queue:

- The task is stored inside the queue, in FIFO order
- The jobs count is incremented by one

When a print task is sent to a printer:

- The print task is removed from the queue, in FIFO order
- The jobs count is decremented by one

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

- The classes
- properties
- appropriate methods

[9]

(ii) Explain the meaning of the terms:

1. inheritance [2]

2. polymorphism [2]

The printing shop wishes to implement a circular queue to limit the maximum number of pending jobs and improve the performance of their system.

(b) **(i)** State two differences between a linear queue and a circular queue. [2]

(ii) Suggest whether inheritance or polymorphism is a more suitable principle to apply in the implementation of both linear queue and circular queue in the same program. Explain your answer. [4]

(c) Using a suitable diagram, pseudocode, or other method, show how an item would be added to a circular queue implemented with a static array. [4]

4 An algorithm for sorting an array of elements is shown.

```
01 FOR i = 1 to Array.LENGTH - 1
02     FOR j = 1 to Array.LENGTH - 1
03         IF Array[j] > Array[j+1]
04           THEN
05             t = Array[j]
06             Array[j] = Array[j+1]
07             Array[j+1] = t
08         ENDIF
09     ENDFOR
10 ENDFOR
```

(a) (i) State the algorithm represented. [1]

(ii) State the time complexity of this algorithm. [1]

(iii) Copy and complete the trace table below with the value of `Array` at the end of each iteration of `i` in the algorithm. [5]

i	Array
Initial	[2, 3, 4, 5, 6, 1]
1	
2	
3	
4	
5	
6	

(b) Describe **two** improvements that could be made to the above algorithm to improve its efficiency. [4]

(c) Explain why insertion sort is usually used instead of bubble sort, although both have the same time efficiency. [2]

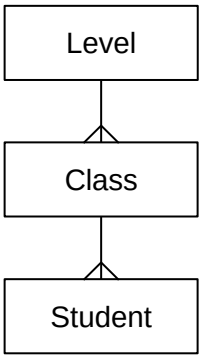
5 A school database has some data in the following table:

StudentID	Student Name	Class	Subjects
1	Wong Yong Ming	1917	H2MATH, H2PHY, H2CHEM, H2ECON
2	Vikram Singh	1911	H2MATH, H2CHEM, H2ECON, H1GEOG
3	Muhd Bashir bin Ramdan	1911	H2MATH, H2CHEM, H2ECON, H1ELIT

(a) (i) State and explain if the above table is in third normal form (3NF). [4]

(ii) Describe two advantages that normalised data has over redundant data. [2]

In an effort to improve the school database, the IT administrator came up with an ER diagram. Part of the full ER diagram is as shown.



Each of the three entities in the ER diagram has a `name` attribute.

(b) (i) Write table descriptions to implement the above ER diagram. [5]

(ii) Write an SQL query to retrieve only the student name and class name for all students in the level `JC2`. [3]

A fast-growing startup is writing code to provide a new service. The user needs have not yet been fully determined, and the data schema is likely to undergo further changes before being finalised.

(c) (i) Suggest if SQL or NoSQL is more suitable for the needs of this startup. Give **two** reasons to support your answer. [4]

(ii) Describe **two** challenges the startup will face in using NoSQL databases. [2]

(d) The startup is concerned that a hardware failure may wipe out critical data and leave them unable to continue operating.

Suggest what the startup should do to **ensure** that they are safe against data loss in such a scenario. [4]

6 Alice, a programmer, is implementing a DNS cache using a hash table.

(a) Explain the purpose of the hash function in a hash table. [2]

The description for a particular hashing algorithm using rolling polynomials is as follows:

For each character in the data, do the following:

1. Let `i` represent the position of the character (1st char = 1, 2nd char = 2, ...)
2. Let `ascii` represent the ASCII value of the character
3. Calculate the sum of `i`×(31^`ascii`) for all characters

(b) Implement this algorithm in pseudocode.

You may assume that the function `Ord()` is available, which takes in a single character and returns the ASCII value of the character. [4]

(c) Bob, another programmer, suggests that a Binary Search Tree would be a more appropriate data structure for the DNS cache.

(i) Describe one advantage of using a hash table for the DNS cache. [2]

(ii) Describe one advantage of using a Binary Search Tree for the DNS cache. [2]

(d) (i) State the algorithm used to retrieve the **sorted** contents of a cache from a Binary Search Tree. [1]

(ii) Using any appropriate diagrams, pseudocode, or other appropriate method, show how this algorithm might be carried out. [5]

(iii) Explain why the Binary Search Tree might need to be periodically recreated. [3]

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