ANGLO-CHINESE JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION

Higher 2

COMPUTING 9569/01

Paper 1 Written **31 August 2022**

3 hours

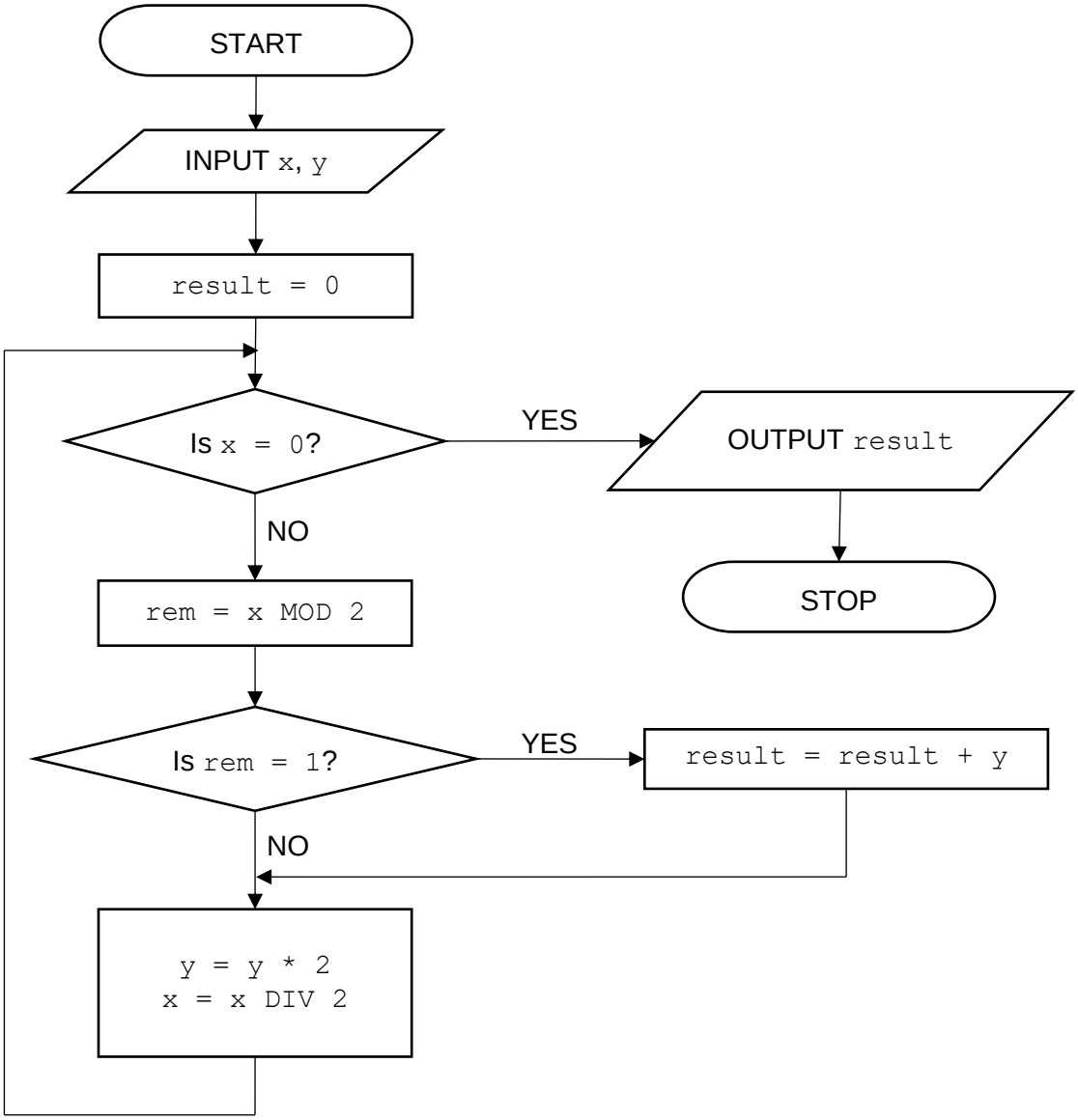
READ THESE INSTRUCTIONS FIRST

An answer booklet will be provided with the 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.

1 The flowchart below shows an algorithm for multiplying two integers, `x` and `y`.



(a) Draw trace tables for the following inputs.

(i) `x = 5, y = 12` [3]

(ii) `x = 12, y = 5` [4]

(b) Explain why the following steps in the flowchart are easy to carry out when `x` is expressed in binary notation. You may use the values of `x` in **(a)** as examples.

(i) `rem = x MOD 2` [2]

(ii) `x = x DIV 2` [2]

(c) Suggest one boundary test case and one erroneous test case for this algorithm. [2]

2 **(a)** A programmer was hired to write a program to sort an array of integers in ascending order.

(i) Describe the operation of insertion sort. [3]

(ii) State the best case scenario for insertion sort and the time complexity for this scenario. [2]

(b) The pseudo-code for bubble sort is shown below.

```
01 INPUT MyList
02 MaxIndex ← LENGTH(MyList)
03
04 n ← MaxIndex
05 FOR i ← 1 TO (MaxIndex - 1)
06     FOR j ← 1 TO n
07         IF MyList[j] > MyList[j+1]
08             THEN
09                 Temp ← MyList[j]
10                 MyList[j] ← MyList[j+1]
11                 MyList[j+1] ← Temp
12          ENDIF
13      ENDFOR
14 ENDFOR
```

(i) Currently, the pseudo-code sorts an array in ascending order. State how should the pseudocode be modified to sort the array in descending order instead. [1]

(ii) A student suggest that this pseudo-code could be improved. Suggest with explanation, a modification to improve the efficiency of this pseudo-code. [2]

(c) Quicksort and merge sort are two sorting algorithms.

(i) State one advantage of quicksort over merge sort. [1]

(ii) State one advantage of merge sort over quicksort. [1]

(iii) Quicksort is a recursive algorithm. State two characteristics of a recursive function. [2]

3 Object-oriented programming is one programming paradigm.

(a) Explain the difference between a class and an object. [3]

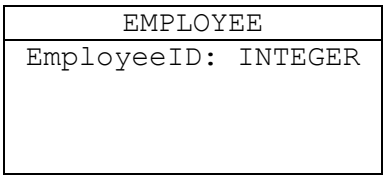
The following scenario is to be implemented with object-oriented programming.

(b) A software company stores data for all employees (`EMPLOYEE`). The company employs admin staff (`ADMIN`) and project staff (`PROJECTSTAFF`). Project staff are either programmers (`PROGRAMMER`) or technical authors (`TECHAUTHOR`).

Data stored will include:

- employee ID for employees
- specialist programming language for programmers
- software specialism for technical authors
- full time or part time indicator
- department for admin staff
- salary grade
- the project team that project staff are assigned to

Complete the class diagram showing **only** the classes and properties for the data given above.



[8]

(c) Explain what is meant by inheritance and give one example of it from the class diagram above. [3]

4 **(a)** A hash table is implemented using an array, h_table. Each element of the array comprises two parts. data_serialno is a string of exactly three characters, while data_score is an integer between 0 and 100 inclusive.

The contents of h_table for index 14 to 20 are shown below.

	data_serialno	data_score	
[14]	123	78	
[15]	223	92	
[16]			
[17]	233	75	
[18]	713	88	
[19]			
[20]	860	46	

The following hashing function is used to generate the hashes.

```
01 FUNCTION GenerateHash(data_serialno: STRING): INTEGER
02     Total <- 0
03     Index <- 1
04         For each Character in data_serialno
05             Total <- Total + INT(Character)*Index
06             Index <- Index + 1
07     Hash = Total MOD 200
08     RETURN Hash
```

(i) `GenerateHash` is called with the parameter of `345`.

Copy and then complete the trace table for `GenerateHash` showing the values of `Index` and `Total`.

Index	Total

[2]

(ii) State the value of `Hash` returned by the function. [1]

(iii) Using pseudo-code, write a function `get_value(data_serialno)` that takes in a `data_serialno` and outputs the `data_score` stored in the `h_table`. You may assume there are no collisions. [2]

(iv) State, giving reasons, the time complexity of `get_value`. [3]

(b) **(i)** The binary search tree is another data structure that could implemented with an array to store the same data. State, giving reasons, whether hash table or binary search tree is the better choice. [3]

(ii) Describe how a binary search tree can be implemented using one or more arrays. [4]

(iii) Draw a binary search tree created with data inserted in the following order.

data_serialno	data_score
233	75
123	78
223	92
713	88
860	46

[3]

(c) A stack is another data structure that could be used to store data.

(i) Explain the concept of a stack. [2]

(ii) Explain the use of a stack when a recursive function is executed. [3]

5 A gym is designing a database to store data about its employees.

- Each employee has a name, ID number and job grade.
- Each employee must belong to an outlet.
- Each job grade has an ID number and salary.

The following set of tables represents a first attempt.

Outlet:

OutletID	**OutletName**
O1	Gem
O2	Moon Vista
O3	East Gate
O4	LCube

Employee:

EmployeeID	**EmployeeName**	**JobGrade**	**Salary**	**OutletID**	**OutletName**
E1	James	J1	5000	O1	Gem
E2	Sally	J2	6000	O2	Moon Vista
E3	Bala	J1	5000	O2	Moon Vista
E4	Molly	J1	5000	O1	Gem
E5	Ahmad	J2	6000	O4	LCube

(a) Explain why the above database is not in third normal form (3NF). [2]

(b) Normalize the tables to third normal form (3NF).

Draw the Entity-Relationship (E-R) diagram to show the tables in 3NF and the relationships between them. [4]

(c) 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.

Write table descriptions for the required tables in the database so that they are in 3NF. [5]

(d) Write an SQL query to output all the names of employees belonging to the LCube outlet. [4]

6 For creating an account at a particular website, users are required to create a password. The password should have at least 8 characters, and contain at least one lowercase letter.

(a) Describe how each of the following checks can be carried out to ensure validity of a password.

(i) Length check [1]

(ii) Presence check [1]

(b) The password is also recommended to contain the following:

- at least one capital letter
- at least one number
- at least one symbol

If it contains all three of them, it is considered a very strong password. If it contains two of them, it is considered a strong password. Otherwise, it is considered a weak password.

Create a decision table to show these conditions and actions. [4]

(c) Explain how verification of the user's password can be carried out when users are creating the password. [2]

(d) On the website's server, the usernames and passwords are stored in a database. The passwords are hashed before they are stored. Explain how this increases the security of the users' accounts, and how verification of the user's identity is carried out on subsequent login attempts. [4]

7 **(a)** The user of a web browser knows the Uniform Resource Locator (URL) of a website which they wish to view.

Explain how the web browser uses the URL to obtain the IP address of the website. [4]

(b) An IPv4 address is entered as 165.299.75.

State two reasons why this IP address is invalid. [2]

(c) A webpage written in a foreign language appears as a string of random meaningless characters when viewed by the user.

(i) Explain how this could have happened. [3]

(ii) Explain how Unicode was intended to resolve such incidents. [2]