



MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level
Higher 2

COMPUTING

9569/01

Paper 1 Written

October/November 2021

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.

This document consists of 8 printed pages.



Singapore Examinations and Assessment Board



Cambridge Assessment
International Education

- 1 A programmer is writing software for a baker who makes celebration (wedding and birthday) cakes to order. All cakes are circular.

The programmer wishes to use object-oriented programming to model the order book and calculate the total price for a cake.

For every cake, the following items of data are recorded:

- an order number
- the customer's name
- the customer's telephone number
- diameter (in cm)
- any special requirements (e.g. must not contain nuts)
- standard price (in \$).

For wedding cakes the number of layers, a maximum of four, is also recorded. The total price is the number of layers multiplied by the standard price.

For birthday cakes the number of candles and price of a candle is recorded. The total price is the standard price plus the number of candles multiplied by the price of a candle.

- (a) Draw a class diagram that shows the following for the situation described above:

- the superclass
- any subclasses
- inheritance
- properties
- appropriate methods.

[12]

- (b) Name **two** suitable validation techniques that might be applied to the number of layers on a wedding cake. [2]

- (c) Explain **inheritance** using examples from this situation. [4]



2 A construction company provides employees to work on projects for clients. Each employee has a specific skill.

- Each project has an ID number and a title.
- Each employee has a name, ID number and a SINGLE skill.
- Each employee can work on a number of projects.
- Each skill has an ID number, name and cost per hour.
- The cost to the client for each employee is the employee's cost per hour multiplied by the number of hours worked on the project.

This table shows typical data from which client charges can be calculated.

Project ID	Project Title	Employee ID	Employee Name	Skill ID	Skill Name	Cost per Hour (\$)	Hours Worked
1	New roof	1	Smith	1	Carpentry	40	45
1	New roof	2	Jones	1	Carpentry	40	30
1	New roof	3	Roberts	2	Bricklaying	45	12
2	Refurbish pool	4	Harrison	3	Electrical	50	15
2	Refurbish pool	5	Harris	4	Plastering	42	20
2	Refurbish pool	6	Patel	5	Tiling	30	35
2	Refurbish pool	7	Staples	5	Tiling	30	42
3	Replace kitchen	2	Jones	1	Carpentry	40	20
3	Replace kitchen	5	Harris	4	Plastering	42	14
3	Replace kitchen	4	Harrison	3	Electrical	50	30
3	Replace kitchen	8	Charles	5	Tiling	30	17

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



The company wants to construct a relational database to store the data shown in the table on page 3.

The following tables contain the data:

Project

Project ID	Project Title
1	New roof
2	Refurbish pool
3	Replace kitchen

Employee

Employee ID	Employee Name	Skill ID	Skill Name	Cost per Hour (\$)
1	Smith	1	Carpentry	40
2	Jones	1	Carpentry	40
3	Roberts	2	Bricklaying	45
4	Harrison	3	Electrical	50
5	Harris	4	Plastering	42
6	Patel	5	Tiling	30
7	Staples	5	Tiling	30
8	Charles	5	Tiling	30

ProjectEmployee

Project ID	Employee ID	Hours Worked
1	1	45
1	2	30
1	3	12
2	4	15
2	5	20
2	6	35
2	7	42
3	2	20
3	5	14
3	4	30
3	8	17

(b) Explain why the table **Employee** is not in third normal form (3NF). [2]

(c) 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 **Employee** table each of which are in third normal form (3NF). [3]

(d) State the primary key for the table **ProjectEmployee**. [1]

(e) Draw an entity-relationship (ER) diagram showing the necessary four tables and the relationships between them. [4]



For each project one employee is nominated to be the Project Manager.

- (f) Explain the change that needs to be made to the existing table design to allow the Project Manager on each project to be identified. [2]

The cost of employing an electrician increases to \$52 per hour. The client receives an invoice, at the end of the project, showing the hours worked and charge for each skill. An employee with the skill Electrical can be called an electrician.

- (g) Explain a problem that may arise if the **Cost per Hour (\$)** field for Electrical in the **Employee** table is changed from \$50 to \$52. [2]

An employee with the skill Tiling can be called a tiler.

- (h) Write an SQL query to output the names and hours worked of the tilers who worked on the Refurbish pool project, in descending order of **Hours Worked**. [7]

The construction company maintains a table of employee names and addresses, so the company can send letters to them.

The company also maintains a table of employee bank account details, so monthly payments can be transferred automatically to their bank accounts.

- (i) State **four** actions the construction company must take regarding the collection, disclosure and use of this data under the Personal Data Protection Act. [4]

- 3 (a) Explain how a denial of service (DOS) attack can compromise an internet server. [2]

A news website posts an article that attracts unusually large worldwide attention. The monitoring software, running on the news website server, warns the system administrator that the site might be the victim of a denial of service attack.

- (b) State **two** reasons why the monitoring software generates the warning. [2]

A server connected to the internet provides web hosting, file transfer and email services. Clients send requests to this server using an internet protocol.

- (c) Explain how requests arriving at this server are handled. [2]

A firewall is placed between the internet and the server.

- (d) Explain how the firewall may manage traffic between the server and the internet. [2]

- (e) Describe how a digital signature can be used to give confidence that a received message has not been altered. [6]

- (f) State **two** authentication techniques to limit access to a network application. [2]



- 4 A programmer is writing code to accept, store and process a number of readings from sensors monitoring an experiment. Depending on conditions, the experiment can generate between hundreds and hundreds of thousands of readings. These readings are stored in a data structure.

The programmer has the option of using either a static or a dynamic data structure.

- (a) Explain the advantage of selecting a dynamic over static data structure in terms of memory allocation. [2]
- (b) State **two** problems that might arise if a dynamic data structure is used in terms of memory allocation. [2]

The readings are processed in the order they are stored.

- (c) Identify a suitable data structure and explain your choice. [2]

- 5 A hashing algorithm is to be used to locate a record within a hash table.

- (a) State **three** features that a good hashing algorithm will possess. [3]
- (b) Explain how **two** different records hashing to the same location can be managed. [2]

A social media company has to store and maintain huge quantities of data.

The social media company hashes a user's ID to locate data for that user's account.

- (c) Explain the advantage of using a hash table, in this situation, rather than linear search to locate a record. [2]
- (d) Explain the disadvantage of a binary search in this situation. [2]

- 6 ASCII allows characters to be stored in memory by associating a number with each character. In memory, that number is stored as a pattern of bits.

The decimal value representing 'A' in ASCII is 65.

- (a) Represent this value in:
 - (i) Binary [1]
 - (ii) Hexadecimal. [1]

The decimal value representing 'a' in ASCII is 97.

- (b) State the hexadecimal value that must be added to the ASCII code for 'A' to convert it to the ASCII code for 'a'. [1]

Unicode is another method of encoding characters.

- (c) (i) State the values that are common to both ASCII and Unicode. [1]
- (ii) Explain what advantage Unicode has over ASCII. [2]



- 7 The nodes of a binary search tree holding names in alphabetical order are stored in the elements of an array, `Names`.

Each element of the array `Names` comprises three parts: a left pointer, the data and a right pointer.

LPtr	Data	RPtr
------	------	------

The pointers contain the array index of a node to either the left or right of the current node. **Null** indicates there are no further nodes in a particular direction.

An integer variable, `Root`, holds the index of the root node.

The contents of the array `Names` are shown:

	Index	LPtr	Data	RPtr
Root	0	Null	Peter	Null
	1	3	Leona	5
1	2	Null	Alice	Null
	3	2	Bobbie	6
	4	Null	Tom	Null
	5	0	Simone	4
	6	Null	David	Null

- (a) Draw the binary search tree represented by the data in the array `Names` and the value in `Root`. [2]
- (b) A new name, **Eric**, is to be inserted into the binary search tree. Show the changes to the array `Names` after this insertion. [2]
- (c) Using pseudo-code, write a recursive procedure that takes the value in `Root` and outputs the result of an in-order traversal of `Names`. [5]



- 8 The following function returns the factorial of a given positive integer.

```
FUNCTION factorial(n)
  IF n = 1 THEN
    RETURN 1
  ELSE
    RETURN n * factorial(n - 1)
  ENDIF
ENDFUNCTION
```

There will be recursion for values of n greater than 1.

- (a) Explain how a stack is used when a recursive call is made. [4]
- (b) State **three** features of a successful recursive function. [3]
- (c) Name an error that might be returned by this recursive function when the value in n is very large. [1]
- (d) Name the type of error identified in your answer to **part (c)**. [1]

