



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



COMPUTING

Paper 1 Written

9569/01

October/November 2023

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 7 printed pages and 1 blank page.



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- 1 A car hire company needs a relational database to store data about cars, customers and the cars hired. Cars are hired for a minimum period of one day and the charge is calculated as the number of days multiplied by the day rate. If a car is used for part of a day, a full day is charged.

There are **four** categories of cars: sub-compact, compact, regular and luxury. The category determines the day rate. All cars in each category have the same day rate.

An initial database was designed with three tables:

```
Car(RegistrationNumber, Make, Model, Category, DayRate)
```

```
Customer(DriverLicenceNumber, Name, Address, TelephoneNumber)
```

```
Hire(RegistrationNumber, DriverLicenceNumber, DateHired,
     DateExpectedBack, DateReturned)
```

(a) The database needs to be normalised.

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

(ii) State **one** drawback of the table Car **not** being in 3NF. [1]

(b) The database is changed to include **four** tables:

```
Car(RegistrationNumber, Make, Model, CategoryName)
```

```
Category(CategoryName, DayRate)
```

```
Customer(DriverLicenceNumber, Name, Address, TelephoneNumber)
```

```
Hire(RegistrationNumber, DriverLicenceNumber, DateHired,
     DateExpectedBack, DateReturned)
```

Identify the primary and foreign keys in each table. [6]



- (c) Create an entity-relationship (ER) diagram for the four-table database. [4]
- (d) Data needs to be validated and verified on entry.
- (i) State **two** ways the driver licence number can be verified on entry. [2]
 - (ii) State **three** ways the date expected back can be validated on entry. [3]
- (e) The company is considering both native and web applications to allow customers to book cars using the internet.

State **two** advantages and **two** disadvantages to the company of creating a native application instead of a web application. [4]



- 2 A programmer is developing a program that includes a data structure. They have the option of using static or dynamic memory allocation for the data structure.

- (a) State **two** benefits of using static memory allocation for the data structure. [2]
- (b) State **two** benefits of using dynamic memory allocation for the data structure. [2]
- (c) Give **one** example where static memory allocation is more appropriate than dynamic memory allocation. Justify your choice. [2]
- (d) A stack and linked list are both examples of data structures where dynamic memory allocation is often more appropriate than static memory allocation.

Give **one other** example of a data structure where dynamic memory allocation is more appropriate than static memory allocation. Justify your choice. [2]

- (e) A linked list is implemented as a 1-dimensional array of nodes.

Each node contains two items of data:

- `data` an item of data
- `next` a pointer (array index) to the next node.

`head` is a pointer to the first node.

A value of `-1` in `head` indicates an empty list.

A value of `-1` in a pointer indicates that it is the last node in the list.

Write a pseudocode function `find()` that:

- has three parameters:
 - a linked list (array of nodes)
 - a value to find
 - the linked list's `head` pointer
- follows the pointers in the list
- returns either the pointer to the node where the value is found or `-1` if the value is **not** in the list.

[6]

- (f) A stack is created using a 1-dimensional array that stores a maximum of 100 elements.

A `top` pointer stores the index of the item at the top of the stack. A `top` pointer of `-1` represents an empty stack.

Write a pseudocode function `push()` that:

- has three parameters:
 - a stack (array of elements)
 - a value
 - the stack's `top` pointer (global)
- if stack is **not** full, inserts value onto the top of the stack and returns `True`
- otherwise, returns `False`.

[4]



- 3 A company that manufactures cooking appliances is designing the control system for each appliance using Object-Oriented Programming (OOP).

All appliances have these features:

- turn on
- turn off
- set timer
- start timer
- end timer
- start alarm
- stop alarm.

There are three different appliances: conventional oven, fan oven and microwave oven (commonly called a "microwave").

The conventional oven has these additional features:

- set temperature
- display set temperature
- display current temperature.

The fan oven includes all the conventional oven features and these additional features:

- start fan
- stop fan.

The microwave has these additional features:

- set power
- display current power.

- (a) Draw an inheritance diagram for this system showing the base class and any derived classes. Do **not** include any attributes or methods. [4]
- (b) Give the attributes and methods of the appliance class. [4]
- (c) Explain why some attributes and methods in classes should be declared as private. [2]
- (d) State what is meant by polymorphism. [1]



- 4 Ordered data can be stored in an array, linked list or binary search tree.
- (a) Describe the advantages of storing ordered data in an array instead of a linked list. [2]
 - (b) Describe how a binary search tree is built up as data items are inserted one by one. [4]
 - (c) State how two binary search trees can store the same data but have a different shape. [1]
 - (d) A queue can be implemented as either linear or circular.
 - (i) Identify **two** operations that can be performed on a queue. [2]
 - (ii) Identify **two** pointers that are required to implement a queue. [2]
 - (iii) Identify **one** application of a queue. [1]
 - (iv) Describe the advantage of implementing a circular queue instead of a linear queue. [2]
- 5 Jeffrey is sending a message to Kim over a network using a network application. A digital signature is sent with the message.
- (a) (i) Explain how Jeffrey's network application creates a digital signature. [2]
 - (ii) Explain how the digital signature is authenticated by Kim's network application. [3]
 - (b) Internet protocol (IP) is used to route packets of data towards their destination. The internet is a packet-switching network.
- When a host is connected to the internet it needs an IP address.
- (i) State the format of an IPv4 address. [1]
 - (ii) State **two** ways that a host can be allocated an IP address. [2]
 - (iii) Explain what is meant by a packet-switching network. [2]
 - (iv) Describe the role of a router in a packet-switching network. [2]
- Jeffrey's message is transmitted using UTF-8 encoding. UTF-8 is a Unicode standard.
- (c) The letter M is encoded by the hexadecimal value 4D.
 - (i) Calculate the denary base-10 value of 4D. [1]
 - (ii) Give the binary representation of 4D. [1]
 - (iii) Explain **one** advantage of using UTF-8 encoding rather than using ASCII. [2]



- 6 A program implements a Quicksort algorithm to order values into ascending order.

The contents of an array are shown:

10	5	6	82	13	4	6
----	---	---	----	----	---	---

- (a) Explain how a Quicksort algorithm will sort the data in the array into ascending order. [3]
- (b) Using Big-O notation, state the worst-case time complexity of Quicksort. [1]
- (c) The Quicksort algorithm uses recursion.
- (i) Define the term recursion. [2]
- (ii) Rewrite this pseudocode function using recursion:

```

FUNCTION iterative(number1)
    total = 10
    WHILE (number1 != 0)
        total = total + 3
        number1 = number1 - 1
    END WHILE
    RETURN total
END FUNCTION

```

[4]

- 7 A pharmacy dispenses medicine prescribed by a doctor. It has a computer system that stores data about its customers including: name, address, date of birth, list of medicines dispensed and the date when each medicine was dispensed.

Describe how the pharmacy can make sure that the data stored complies with the Personal Data Protection Act in Singapore. [4]

- 8 A technician is testing the control system software for a nuclear power station before implementation. They find a fault that, if **not** corrected, could have catastrophic consequences. The technician reports the error to their manager, who is a computer professional. The manager's response is:

'The delivery of the system to the client on time is more important. The error can be fixed later, and a patch issued after the control system is installed and operational.'

Discuss whether the manager is abiding by the code of ethics of a computer professional. [5]



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