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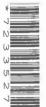Higher 2

COMPUTING

9569/01

Paper 1 Written

October/November 2020

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 **9** printed pages and **3** blank pages.

[Turn over

1   A software company is writing a program for a vehicle hire business. Both cars and vans are available for hire.

For all vehicles, the data that will be stored include:

    Vehicle Registration Number (VRN)
    Model
    Total distance travelled (km)
    Date hired
    Date of return
    Cost per day
    Available for hire

For cars, the additional data stored include:

    Number of seats
    Fuel type (petrol, diesel, electric, hybrid)

For vans, the additional data stored include:

    Load volume (m^3)
    Maximum load (kg)

The odometer in the vehicle displays the total distance the vehicle has travelled since manufacture.

When a vehicle is hired:

- total distance travelled is set to the odometer's value
- date hired is set to the current date
- return date is set to the date the vehicle is expected to be returned
- available for hire is set to FALSE.

When a vehicle is returned:

- hire cost is returned as the cost per day multiplied by the number of days the vehicle was hired
- total distance travelled is set to the odometer value
- date returned is set to the current date
- available for hire is set to TRUE.

Object-oriented programming will be used to model vehicles.

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

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

[12]

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

Objects provide encapsulation of properties and methods.

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

The business wants to change the way the hire cost is calculated for a car. As well as charging per day, an additional charge of $0.05 is to be made per km travelled during this hire.

(d) Suggest a change to the class diagram to enable the new charging scheme to be used for cars. [1]

(e) State the purpose of polymorphism. [1]

2   Quicksort is an algorithm to arrange data items into ascending or descending order. The algorithm selects a pivot from the data set. The data set is divided into two subsets around the pivot.

   (a) (i)   State the ideal pivot for the quicksort algorithm to execute most efficiently.   [1]

       (ii) State the difficulty in locating this ideal pivot.   [1]

Sometimes the item in the first or last position in the data set is used as the pivot. An alternative is to pick the pivot at random.

A given data set is largely sorted.

   (b) Explain what advantage random selection has over selecting the item in the first or last position.   [2]

   (c) Explain why a programmer might choose to use an insertion sort rather than quicksort in this situation.   [4]

3   A binary search tree is implemented using an array, `b_tree`. Each element of the array comprises three parts; `l_ptr` and `r_ptr` are of data type integer and `data_item` is of data type char.

l_ptr	data_item	r_ptr

The root of the binary search tree is stored in an integer variable, `root`.

The contents of `b_tree` is shown below. −1 represents the null pointer.

Index	l_ptr	data_item	r_ptr
0	−1	A	−1
1	0	+	2
2	−1	B	−1
3	1	*	5
4	−1	C	−1
5	4	−	6
6	−1	D	−1

root
3

   (a) Draw the binary search tree represented by the array `b_tree`.   [2]

   (b) State the index of a leaf node in `b_tree`.   [1]

A procedure, P, uses recursion.

```
01 PROCEDURE P(Index: INTEGER)
02    IF b_tree[Index].l_ptr <> -1 THEN
03        P(b_tree[Index].l_ptr)
04    ENDIF
05    IF b_tree[Index].r_ptr <> -1 THEN
06        P(b_tree[Index].r_ptr)
07    ENDIF
08    OUTPUT b_tree[Index].data_item
09 ENDPROCEDURE
```

(c) (i) State what is meant by **recursion**. [1]

(ii) State the line numbers that indicate procedure P is recursive. [1]

(iii) State the significance of lines 02 and 05. [1]

Procedure P is called with the parameter value of 1.

(d) Copy and then complete the trace table for procedure P showing the values of Index and the output.

Index	Output
1	

[5]

(e) Explain the use of a stack when the recursive procedure P executes. [3]

(f) Identify the type of tree traversal that procedure P performs. [1]

A 1-dimensional array is used to hold a queue.

(g) Explain the concept of a queue. [2]

Queues can be either linear or circular.

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

4 A computer on LAN A wants to send data to a computer on a remote LAN B.

The internet is used to provide a data path between the two LANs.

(a) (i) State **two** ways that a particular device can be identified on a LAN. [2]

(ii) State **two** reasons why LANs need communication protocols. [2]

IP is the protocol used to transfer packets of data between hosts and routers on the internet.

The internet is a packet-switched network.

(b) (i) Explain the term **packet-switching**. [3]

(ii) Describe a disadvantage of packet-switching and how the problem can be handled. [3]

(iii) State how a packet-switched network can cope with a broken cable on part of the network. [2]

When using a web browser, most users do not know the IP address of the server hosting the desired web page. So users enter the domain name instead, which the browser sends to a local domain name server (DNS).

(c) Describe the actions that would be carried out by the local DNS on receiving this request. [4]

(d) State the security feature that can be used as a precautionary measure when sensitive data is sent across a network in each of the following situations:

(i) No one other than the intended recipient of the message should be able to read it. [1]

(ii) The intended recipient must be confident that the message is from the identified sender. [1]

5 Validation and verification are used in data entry.

(a) (i) State the purpose of verification. [1]

(ii) State **one** method of verification. [1]

The use of check digits is one validation technique.

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

(ii) State **three** other validation techniques. [3]

(iii) Name **two** types of error that check digits usually detect. [2]

A check digit is to be added to the end of 02757 using Modulus 11. The weight of each digit, starting with the first digit (0) is 6, 5, 4, 3, 2.

(c) Showing your working, determine the check digit for 02757. [3]

(d) Give **two** reasons why the data type of a field storing 02757 with a Modulus 11 check digit should be a string rather than an integer. [2]

6 A college is designing a database to store data about:

- students
- courses
- subjects
- teachers
- classrooms.

The designers are told that:

- each student takes four courses
- each teacher delivers all their lessons in one room
- each room may be used by more than one teacher
- each teacher may teach more than one course
- a course can only be taught by one teacher
- a subject may be taught by more than one teacher.

A first attempt is represented by the following table:

Student ID	First Name	Last Name	Course ID	Subject	Teacher ID	Teacher Name	Room Number
1279	Joe	Smith	934	Geography	334	Mansoor	12
			926	Maths	451	Yang	16
			882	Physics	628	Lee	12
			425	Computing	329	James	14
1395	Muhammad	Hilmi	934	Geography	334	Mansoor	12
			927	Maths	723	Morris	8
			883	Physics	534	Weston	10
			586	French	271	Dubois	16
2883	Sumiko	Chong	425	Computing	329	James	14
			882	Physics	628	Lee	12
			934	Geography	334	Mansoor	12
			586	French	271	Dubois	16

(a) Explain why this table is not in first normal form (1NF). [2]

The following is an attempt to reduce data redundancy:

Student

Student ID	First Name	Last Name
1279	Joe	Smith
1395	Muhammad	Hilmi
2883	Sumiko	Chong

Course

Course ID	Subject	Teacher ID	Teacher Name	Room Number
934	Geography	334	Mansoor	12
926	Maths	451	Yang	16
882	Physics	628	Lee	12
425	Computing	329	James	14
927	Maths	723	Morris	8
883	Physics	534	Weston	10
586	French	271	Dubois	16

IsTaking

Student ID	Course ID
1279	934
1279	926
1279	882
1279	425
1395	934
1395	927
1395	883
1395	586
2883	425
2883	882
2883	934
2883	586

(b) Give suitable primary keys for each of the following three tables.

   (i) Student   [1]

   (ii) Course   [1]

   (iii) IsTaking   [1]

(c) Create an entity-relationship (ER) diagram showing the degree of all relations.   [3]

(d) Explain why table Course is not in third normal form (3NF).   [2]

(e) 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 they are in third normal form (3NF).   [7]

(f) Explain the reasons for reducing data redundancy in a relational database.   [2]

(g) Write an SQL query to output the subjects, teacher names and room numbers for the courses taken by the student with Student ID of 1395.

The output is to be in alphabetical order of subject.   [5]

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