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A company sells televisions over the Internet. The company keeps records in a computer file. Each record includes the following details about each type of television:

- TVNumber
- Description
- Price
- NumberInStock

The records are stored in ascending order of TVNumber.

(a) A new program is to be written to search for a television using its TVNumber. The programmer has been asked to use a binary search or a linear search.

- (i) Describe the operation of a binary search. [3]
- (ii) Describe the operation of a linear search. [3]

Explain Step by Step. Be clear in describing your variables. Be clear how calculations are done/explained. Be clear what is being compared/what happens in each scenario. Answer qns like these: How did you calculate which index to start? What (exactly) are you comparing? What happens in each scenario? Is it done only once? If not, when does it stop?

(iii) State, giving reasons, whether a binary or a linear search would be more efficient. [3]

Be familiar with the algorithm. Did it read from all  $n$  elements? Then it is  $O(n)$   
Did it skip elements? Halving it each time? Then it is  $O(\log n)$   
Finally, answer the question, which is better?

(b) List the entries in the order they are accessed during a binary search for the record with TVNumber 43. The records stored have these TVNumbers:

27, 32, 41, 43, 81, 92, 101, 103, 109, 142, 164 [2]

List the entries in the order they are accessed [2marks only]. No need to explain.

The records are to be resorted into NumberInStock order. One sort algorithm that could be used is an insertion sort.

(i) Show how these values for NumberInStock could be sorted into descending order using an insertion sort. 23, 17, 45, 3, 7 [3]

No need to describe, show the sequence after every step.

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(ii) Another sort algorithm that could be used is a bubble sort. Describe the operation of a bubble sort and show how the values from (c)(i) could be sorted into descending order using this sort. [4]

Need to describe the operation of bubble sort.

Show the sequence after every step.

2.

The recursive function X has one parameter, Index.

```
01 FUNCTION X(Index : INTEGER) RETURNS INTEGER
02 IF Index = 0
03 THEN
04 Y ← 1
05 ELSE
06 Y ← Index * X(Index - 1)
07 ENDIF
08 RETURN Y
09 ENDFUNCTION
```

(a) State what is meant by a recursive function. [2]

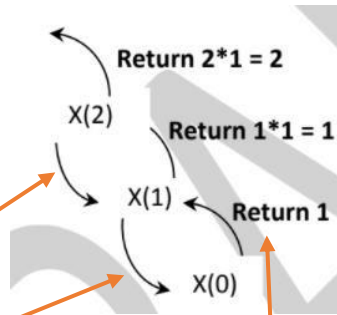
2m: What is different for recursive functions when coding it? What is the concept of a recursive function? Does it repeat, and if so, when does it stop?

(b) Give the line number that indicates the function X is recursive. [1]

1m only. Just state the line number.

(c) An example of a trace tree diagram showing the recursive function call X(2) is shown as follows:

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Use the above example to create a trace tree diagram for the recursive function call  $X(4)$ . [4]

$X(2)$  needs to wait for the result of  $X(1)$  to continue.

$X(1)$  needs to wait for the result of  $X(0)$  to continue.

$X(0)$  fulfills a terminating condition and can immediately return a value.

$X(1)$  can now calculate its result and return a value.

$X(2)$  can now calculate its result and return a value.

(d) Describe the purpose of function  $X$ . [1]

Describe what it does, for which variable name.

(e) Give one limitation of the function  $X$ . [1]

Look at the given function  $X$  to find any limitations: problems/flaws. Any syntax/logic/runtime errors/infinite loops?

3.

A car chase computer game has been designed for players aged 18 years and over. Part of the program to be designed and written, completes the following tasks:

- checks that a new player's name has not been used before
  - stores the player's name and age in a binary search tree in alphabetical order of name •
- provides an alphabetical list of all players

(a) The binary search tree that has its data inserted in the following order.

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Ryan 18

Bella 21

Joshua 27

Shane 20

Jasmine 18

Alexis 27

Draw the binary search tree. [4]

Be familiar with what is a binary search tree.

(b) (i) Describe how the binary search tree in part (a) can be implemented using one or more arrays. [4]

4m: Need to describe what kind of array, 1D? 2D? What information does it contain?

(ii) Show the contents of this data structure. [2]

Show what your array would contain to represent the bst in (a).

(c) (i) Using the binary search tree, describe how the program could check that a name has not already been used. [2]

Qn is 2m only. Do you need to describe how you go through the entire tree?

(ii) Using the binary search tree in part (a), describe how the program would provide an alphabetical list of all players. Include in your description how the result from the binary search tree in part (a) would be obtained. [6]

Describe how you start (which part of the tree?).

Describe: Are selecting the value at the node, or are you just visiting?

If not, which pointer do you use? And why? What order are you doing? Pre/In/Post-order traversal?

Is this done repeatedly in a loop? Or using recursion?

How did you get the first person in your alphabetical list? Second? Third? Fourth? Fifth? Sixth?

What are the terminologies you need to make your explanation shorter and clearer? (Node, Visit, Select, Root of the Tree, Left/Right pointer, Left/Right subtree)

4.

Customers input the amount of money they want to withdraw from their bank account into an Automatic

Teller Machine (ATM). The ATM will dispense the money only if the amount is no more than the account balance and no more than the withdrawal limit on the account. The ATM will also check the amount of money held in the ATM, and offer the amount available if it is less than the amount requested. Otherwise the transaction will be cancelled.

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

What does a decision table comprise of?

What are all the conditions you need to check? (Create a row for each)

What are all the possible actions/outcomes that can happen? (Create a row for each)

Can you exhaust all the possible Scenarios/Rules that can happen using permutation? (Create a column for each)

(b) Remove the redundancies from the decision table. [2]

Simplify table: by looking at columns that have the same actions/outcomes

(c) Write pseudo-code to input the amount of money, check the account balance, the withdrawal limit, the amount of money in the ATM and then output one of these messages:

- "account balance exceeded"
- "withdrawal limit exceeded"
- "cash will be dispensed"
- "ATM can only dispense " AmntATM

Use the variable names in table 4.1 in your pseudo-code. [10]

Name	Use
Amount	Amount of money input
AccBal	Account balance

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WithLmt	Withdrawal limit
AmntATM	Amount of money in ATM

**Table 4.1**

Follow the question specifications. Get 1 input, do checks against 3 numbers, show 1 output. Use your decision table to help you. If trying to do closed book, look at Qn 2 to see some examples of pseudocode given to you in the question.

5.

A company rents holiday apartments to customers. A customer usually makes a booking a number of months before the start of the rental period. The customer pays a deposit at the time of the booking and the balance (the remaining money owed) a month before the start of the rental.

At the time of a booking, the company records the following data:

- customer name and address, if the customer has not made a booking before
- customer reference code
- booking date
- rental start date
- rental completion date
- apartment type
- deposit taken

Apartment types are coded as follows:

- A1 for one-bedroom apartment
- A2 for two-bedroom apartment
- A3 for three-bedroom apartment

Each apartment type has its own daily rental.

Each apartment has a unique number.

Each customer may make more than one booking.

(a) The company wants to model this application using a relational database.

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(i) A database needs a number of tables to store the data for this application.

Draw the Entity-Relationship (E-R) diagram to show the tables in third normal form (3NF) and the relationships between them. [7]

Identify your entities and link entities (How many boxes)?

Which is the link-entity joining 2 entities together?

(ii) 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**. Using the information given, write table descriptions for the tables you identified in part (a)(i). [7]

Use (i). For every entity/link-entity, there is a table. What are its fields?

What fields are unique? Those are usually useful as keys.

ER diagram boxes that has crows-foot (link-entities) need a foreign reference.

(iii) Explain the purpose of any foreign keys that have been used using the table descriptions you wrote for part (a)(ii). [2]

Explain which table, which field, makes a reference to the primary key in which other table.

(b) The company wishes to provide a global service with apartments all over the world that can be booked at very short notice. The database will be expanded to include a wider range of information. Each apartment may have different types of information stored about it. This information could include, video, audio and web pages. The company is investigating using a NoSQL Database Management System (DBMS) rather than a relational database.

State three reasons why the company may wish to choose a NoSQL DBMS. [3]

You must know the advantages of a NoSQL DBMS (vs relational database).

Try to list 3 that are applicable in the question's context.

Context:

Global Service/Apartments, all over the world, database expansion:

Database expanded to/different fields/different types of data (flexible/unknown fields):

Booked at very short notice (Fast/Efficient):

Expansion of database must not affect current data/cause downtime:



6 A company has many offices at different sites in many other countries. Each office is able to access data stored on the network servers at the company headquarters. The offices access data using the Internet.

(a) Describe two threats that could compromise company servers. For each threat explain how the servers and the data stored on them could be protected and identify any limitations of the protection. [8]

(b) Data transferred over the internet from the company headquarters needs to be kept secure. Explain the security features that should be used in order to ensure this data would be protected during transfer. [6]

7 Computing professionals are usually required to conduct themselves ethically. A company has asked you to write a code of conduct for the computing professionals employed by that company.

The areas of conduct that should be included in the company's computing professionals' code of conduct include:

- Integrity
- Responsibility
- Competence
- Professionalism

(a) Give one example of a rule that you would expect to be included in each area of conduct.

Each rule given must be different. [4]

<https://www.scs.org.sg/membership/code-of-conduct>

**Integrity :** Computing professionals are usually entrusted to working with IP/private data. Also expected to being truthful about one's qualifications/area of expertise.

**Responsibility :** To know and follow standards/guidelines/specifications, and to advise the customer of the consequences when they are not followed.

**Competence :** To upgrade skills. Be aware of developments in their field of expertise.

**Professionalism :** Do not defame others, speak on behalf of others without permission.

(b) For two of your rules give an example of the unethical behaviour it is designed to prevent. [2]