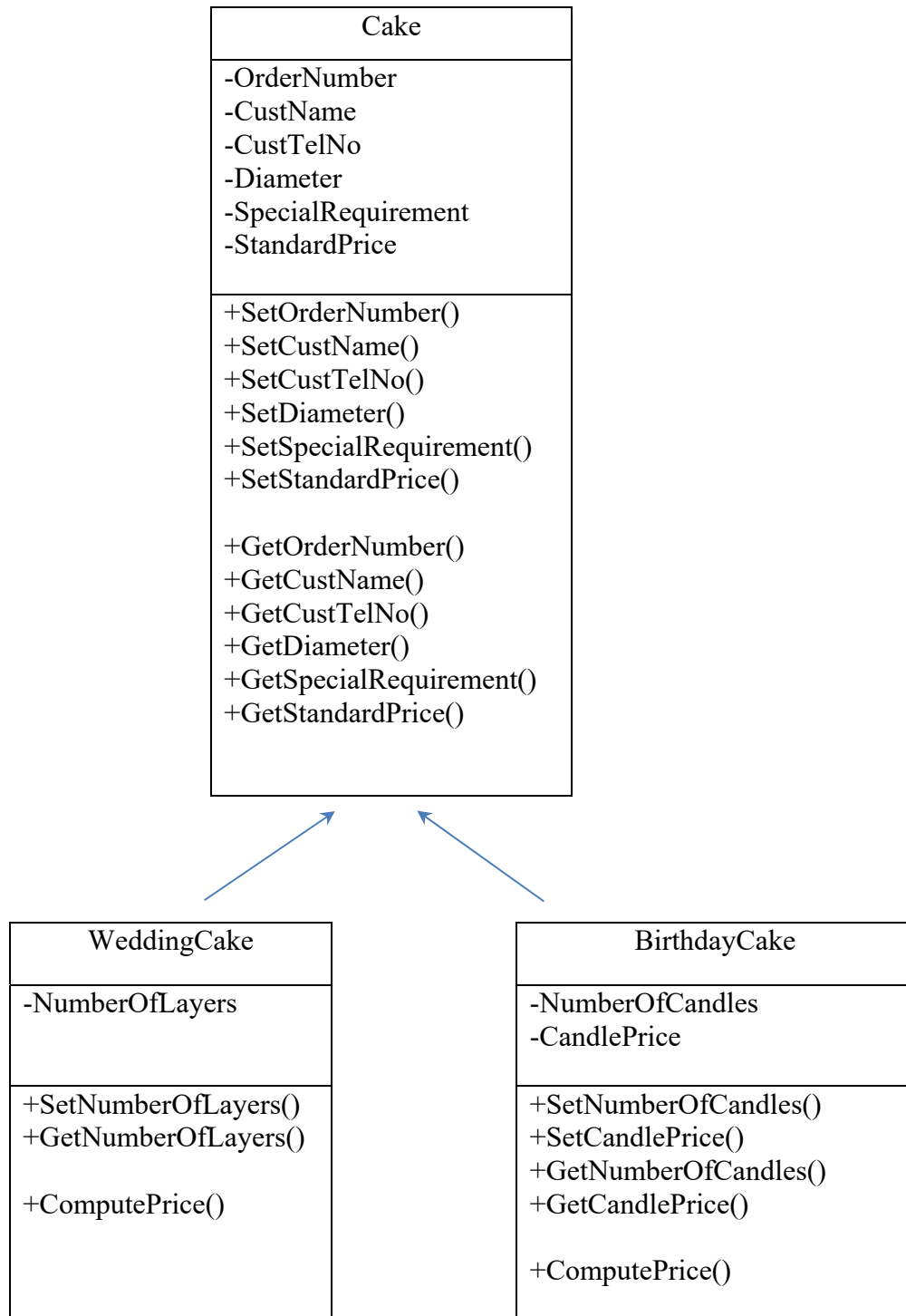


2021 A Level Written Paper Suggested Solution

Question 1

(a)



(b)

- Presence check – checks that number of layers field cannot be left blank
- Range check - checks that number of layers must be greater equal to 1 and less than equal to 4
- Type check – checks that number of layers field is of integer type

(c)

- Child class can inherit all properties and methods from its parent class
- Provides code-reusability
- Child class can have its own properties and methods
- e.g. the WeddingCake child class inherits the attributes OrderNumber, CustName, CustTelNo, Diameter, SpecialRequirement, StandardPrice, and their setter and getter methods from parent class Cake and there is no need to declare these attributes and methods again
- The WeddingCake subclass only needs to declare its unique attribute NumberOfLayers, and the set and get NumberOfLayers methods.

Question 2

(a)

- The table is in 1NF as each cell in the table contains exactly one value
- and column values are of same data type.
- The three employees who work on the same project 'New roof' are stored separately in three rows.

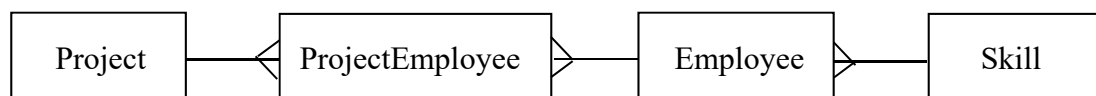
(b)

- Transitive dependency exists
- Employee ID → Skill ID → Skill Name, Cost per Hour
 - Skill ID depends on Employee ID
 - Skill Name and Cost per Hour depend on Skill IDSo, Skill Name and Cost per Hour are transitively dependent on Employee ID via Skill ID.

(c) Employee (EmployeeID, EmployeeName, SkillID)
Skill (SkillID, SkillName, CostPerHour)

(d) ProjectID + EmployeeID

(e)



(f)

Project (ProjectID, ProjectTitle, ManagerID)

- Add a column 'Manager ID' to 'Project' table
- to store the employee id of the project manager
- points to 'Employee ID' in the 'Employee' table as a foreign key

(g)

- If the cost increased is after the electrician has completed the work but before the end of the entire project
- the invoice, generated at the end of the project, will show the wrong charge of \$52 instead of \$50 per hour. The cost calculated for the electrician will be wrong.

(h)

```
SELECT Employee.EmployeeName, ProjectEmployee.HoursWorked
FROM ProjectEmployee
INNER JOIN Project ON Project.ProjectID = ProjectEmployee.ProjectID
INNER JOIN Employee ON ProjectEmployee.EmployeeID = Employee.EmployeeID
INNER JOIN Skill on Employee.SkillID = Skill.SkillID
WHERE (Project.ProjectTitle = 'Refurbish pool') AND (Skill.SkillName = 'Tiling')
ORDER BY ProjectEmployee.HoursWorked desc;
```

(i)

- Consent Obligation
The company must obtain the consent of the employee before collecting, using or disclosing his/her personal data for a purpose
- Notification Obligation
The company must notify the employee of the purpose(s) for which the company intends to collect, use, or disclose his/her personal data on or before this process
- Retention Limitation Obligation
The personal data of the employee that the company had collected should only be kept for as long as it is necessary for legal purposes
- Protection Obligation
The company must protect the personal data of the employee in their possession in order to prevent unauthorized access, collection, use, disclosure, or similar risks

Question 3

(a)

- DOS attacks the network traffic by sending massive request to exhaust server resources and bandwidth
- Disables the server from responding to legitimate requests

(b)

- There is an unusually large number of requests for the news website
- It is likely that someone attempted a DOS attack
- The monitoring software generates warning
- So system administrator can monitor network traffic to confirm the presence of the attack
- Identify the source and mitigate the situation before it affects the server and users

(c)

- When client sends request to the server, the server search for the requested page. If requested page is found then the server will send back a response that contains the page
- If the requested page is not found, server will send an error response: e.g. Error 404 Resource not found
- If client has requested for some other resources then the server will interact with the application server and data store to construct the response

(d)

- Use packet filtering
- Packets are analyzed against a set of user-defined filters, such as IP addresses, content, and port numbers
- Only packets that make it through the filters are allowed to enter the network

(e)

Sender Side:

- generates a hashed version of the message using a hash algorithm
- encrypts the hash with its private key to digital signature
- sends both the message and the digital signature to the receiver

Receiver Side:

- decrypts the digital signature using sender's public key to get the sender's version of hash
- hash the received message with the same hash algorithm
- if the hashed result matches the hash received, it means the received message has not been altered

(f)

- Password authentication: something you know
e.g. a password or personal identification number (PIN)
- Token authentication: something you have
e.g. smart card and OTP
- Biometric authentication: something you are
e.g. fingerprints and voice recognition

Question 4

(a)

- In dynamic data structure, memory size can be increased or decreased according to the requirement
- Memory wastage doesn't occur because it allocates exact memory space
- In static data structure, once the memory is allocated, the memory size cannot change

(b)

- Can overflow if too much memory is used than allocated
- Will get memory leak if you don't release the memory when storage is no longer required

(c)

- Queue
- Queue data structure works in the FIFO principle where first reading stored is the first to be processed

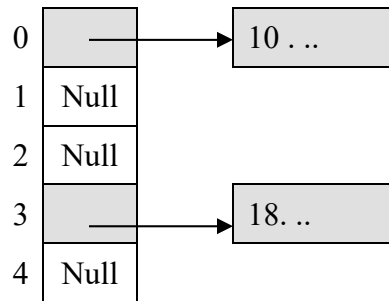
Question 5

(a)

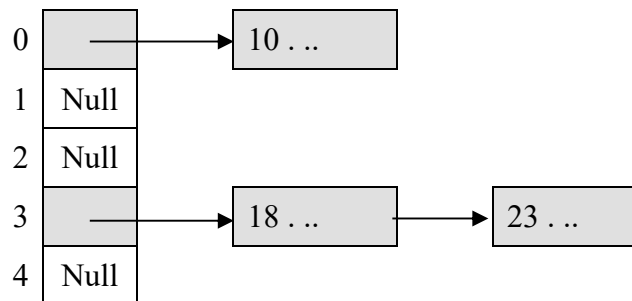
- Easy to compute: It should be efficient and easy to compute
- Uniform distribution: It should provide a uniform distribution across the hash table and should not result in clustering
- Less collisions: Collisions occur when pairs of elements are mapped to the same hash value. These should be avoided

(b) Separate chaining

- Each slot of the hash table is a linked list
- Store all records that hash to the same location in the same linked list
- e.g. consider a hash function: $h(\text{key}) = \text{key} \text{ MOD } 5$
keys 18 and 10 would get 3 and 0 as hash indices respectively.



If we insert a new record key 23 that would also go to the fourth index as $23 \text{ MOD } 5$ is 3.



Or

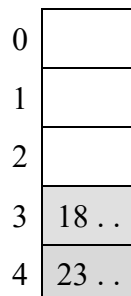
Linear probing

- Perform a circular linear search of the table from the location where the collision occurs
- continue until an empty slot is found
- e.g. consider a hash function: $h(\text{key}) = \text{key} \text{ MOD } 5$

$$h(18) = 18 \text{ MOD } 5 = 3$$

$$h(23) = 23 \text{ MOD } 5 = 3$$

The calculated index of key 23 is 3 which is already occupied by record key 18. The next empty slot to the index 3 is 4; so place record key 23 at the 4th index.



(c)

- Hash tables provide constant-time $O(1)$ lookup on average, regardless of the number of records in the table.
- Linear Search is very slow for large lists. As the number of records in the array/list increases the time complexity also increases.

(d)

- Must use a sorted array
- Requirement of sorted array is expensive when a lot of insertion and deletions are needed while keeping it sorted

Question 6

(a) (i) 0100 0001 (binary) (ii) 41 (hexadecimal)

(b) $97 - 65 = 32$ (decimal) $\rightarrow 20$ (hexadecimal)

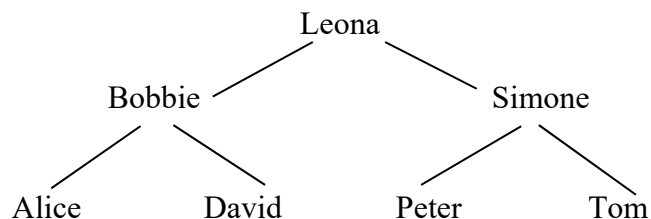
(c) (i) 0 – 127

(ii)

- Unicode (uses 16/32 bits) can represent far more characters than ASCII (uses 7 bit)
- Unicode covers encoding of the texts in different languages whereas ASCII covers encoding of characters of English language.

Question 7

(a) Root: Leona



(b)

Index	LPtr	Data	RPTr
0	Null	Peter	Null
6	Null	David	7
7	Null	Eric	Null

Note: Changes are made in bold

(c) CALL Inorder (Root) // Root: Index of the root node

```
PROCEDURE Inorder (Index: INTEGER)
  IF Index <> Null
    CALL Inorder (Names[Index].LPtr)
    OUTPUT Names[Index].Data
    CALL Inorder (Names[Index].RPtr)
  ENDIF
ENDPROCEDURE
```

Question 8

(a)

- When a function is called, a new activation record that holds the function's parameters, local variables and the return address, is pushed onto the stack
- When the called function returns, its activation record is popped from the stack
- Use this new top activation record to restore the environment of the caller function

(b)

- Must call itself, recursively
- Must have base case(s)
- Must change its state and move forward the base case

(c) Stack overflow error

(d) Run-time error