

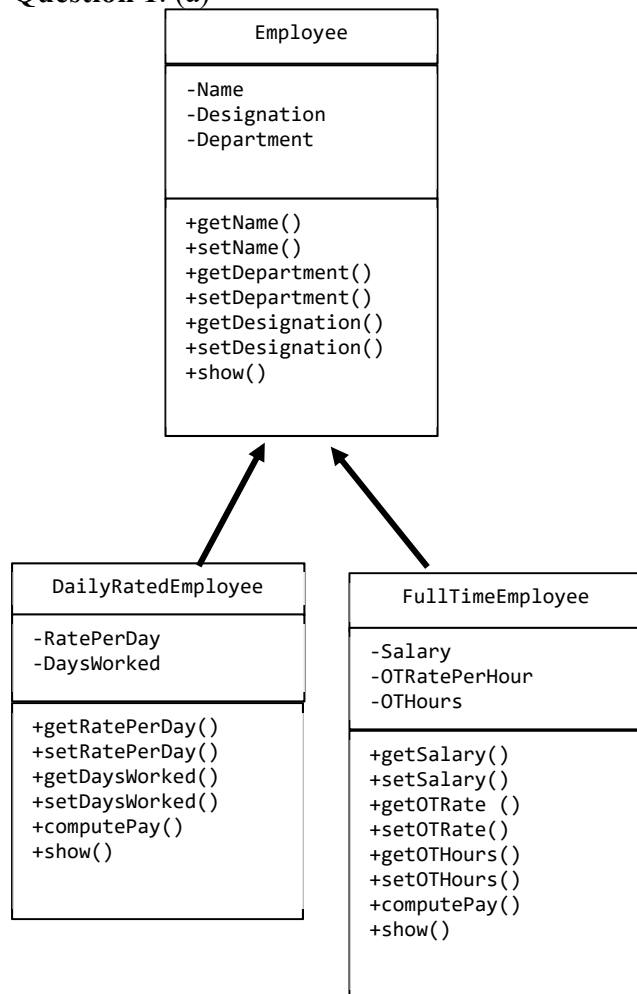
# HWA CHONG INSTITUTION

## C2 PRELIMINARY EXAMINATION 2022

### COMPUTING Higher 2 Paper 1 (9569 / 01) Solution

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#### Question 1. (a)



#### Notes:

1 Superclass with 2 subclasses.

private (-) attributes or methods and public (+) attributes or methods, methods end with ()

get/set methods for **each** attribute.

computePay() method for both subclass.(Since the computation is different for the 2 subclasses)

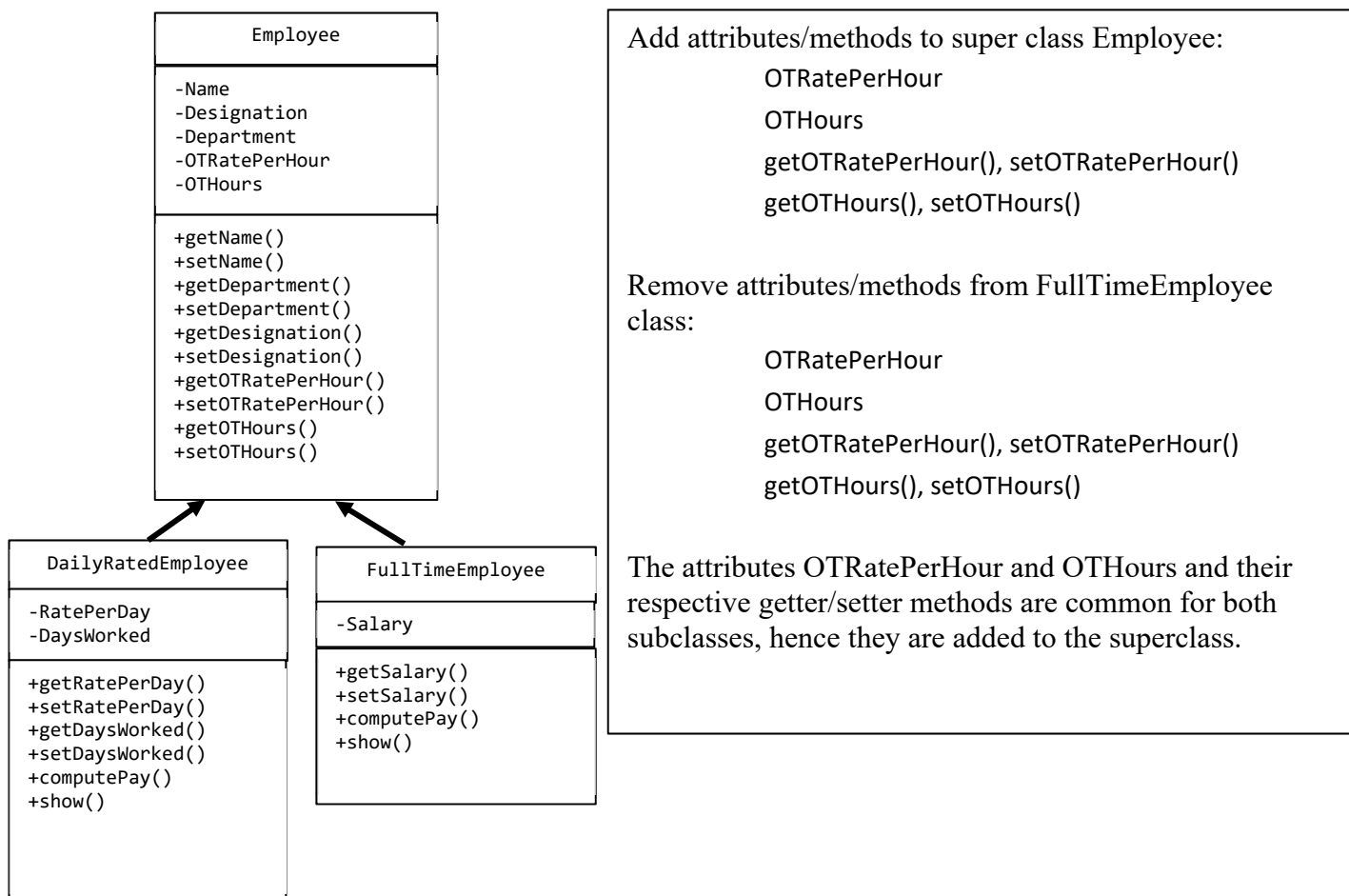
Inheritance - Arrow from subclass to superclass to show inheritance

Polymorphism – show() method for all 3 classes.

(b) The sub-classes (DailyRatedEmployee and FullTimeEmployee) **inherit all the attributes and methods** of the Employee class. The methods **getName, setName, getDepartment, setDepartment, getDesignation, setDesignation** are inherited without changes to the implementation and the no coding are required, hence code reused is achieved.

(c) Polymorphism refers to **an object's ability to take different forms**. It allows subclasses to have methods with the same name as methods in their superclasses. It gives the ability for a program to call the correct method depending on the type of object that is used to call it. The method **show()** in both the subclasses **overrides** the superclass **show()**. If the subclass object (DailyRatedEmployee) is used to call **show()**, then the subclass's version of the method is invoked. If the superclass object (Employee) is used to call **show()**, then the superclass method will be invoked.

(d)



**Marker's Comments:**

Unlike practical, special operation in a Class needs a method to address it, it should not be part of getter/setter methods for an attribute. Example : ComputePay() method should be defined and should not be part of getSalary() or setSalary().

Salary and its setter/getter methods should not be in the Employee class as both subclasses have very different ways of computing the pay as different attributes are used to compute the salary for both Fulltime and Daily-rated employee.

ComputePay() method is defined in both sub-classes as they have different ways of calculating the pay. Full-time employee has a salary component and an overtime allowance (based on hourly rate). These are attributes of the FullTimeEmployee Class. They are used to calculate the pay for Full-time employees. For daily-rated employees, daily-rate and number of days work is used to calculate the pay. So daily-rate and number of days should be attributes of daily-rated employee. Some students are not able to identify the attributes for both subclasses.

**Question 2 (a)**

Day > 7	T	T	T	T	F	F	F	F
Symptom	T	F	F	T	T	F	F	T
Test positive	F	T	F	T	F	T	F	T
Fully Quarantine at home					Y	Y	Y	Y
Work + isolate herself at home	Y	Y		Y				
Back to normal life			Y					

**(b)**

Day > 7	T	T	T	F
Symptom	T	F	F	-
Test positive	-	T	F	-
Fully Quarantine at home				Y
Work + isolate herself at home	Y	Y		
Back to normal life			Y	

(c)

```
DECLARE Day: INTEGER
DECLARE Symptom: BOOLEAN // Symptom = True means sick symptoms
DECLARE Test: BOOLEAN // Test = True means she tests positive
IF Day <= 7
THEN
    OUTPUT 'Fully Quarantine at home'
ELSE
    IF Symptom = True OR Test = True
    THEN
        Output 'Work + isolate herself at home'
    ELSE
        Output 'Back to normal life'
    ENDIF
ENDIF
```

**Marker's Comments:**

1. Some students are not familiar with the formatting of decision table
2. Each case shall have ONLY ONE outcome
3. The condition for the number of days shall be day <= 7 or day > 7. Some students got the equal sign at the wrong place
4. Number of days shall be taken as INTEGER, not BOOLEAN

**Question 3**

(a) Reason for layering: Simplifies the network model; Enables programmers to specialize in a particular layer of the model; Provides design modularity; Allows for standardized interfaces to be produced by networking vendors

(b) At the **Network** layer, router uses **IP address** to send data packets to the designated **host in the network**

At the **Data Link** layer, switch uses **MAC address** to send data frame to the designated **machine in the local network**

(c) Data is **separated** into packets and each packet **independently** find **the best route** to the receiver.

Advantage:

Different packets may travel in **different** route and thus **more efficient**, **saves bandwidth** and **avoids congestion**. It is also more **secured** since it became much harder to attack **all the routes** instead of one route in circuit switching network.

(d)

**Sender Side**

- The sender uses a hash algorithm to **create a hashed version** of the message
- The sender uses **its private key** to **encrypt the hash** to the digital signature
- Both the **message** (encrypted or not) and the **digital signature** are sent to the receiver

### Receiver Side

- The receiver uses the **sender's public key** to **decrypt** the digital signature back to the sender's version of hash
- The receiver uses the **same** hash algorithm to create a **new hash** from the received message
- If the two hashes **match**, it means the data is not altered and is sent by the known sender

(e) Data verification ensures the input data matches the original resource.

Example: enter password twice, proofread before submitting forms

(f) (i) **If server is down, whole network is down.** So the server is more vulnerable to cyberattack; Centralized server is **more expensive** to build up, and **requires professional to maintain.**

(ii)

Virus: attach itself to another program and remains dormant until it is executed by the user. It replicates to infect other computers in the network

Worm: **self-replicating** to infect other computers in the network which aims to **damage** computer systems or gain unauthorized access to them.

Trojan Horse: appears as an legitimate program. Once it gains access into the computer, it runs malicious code to cause damage to the computer

Ransomware: locks the computer or encrypt the data and force the user to pay a ransom to get their computer back

Adware: unwanted software which displays advertisement on the computer

Spyware: hidden program that secretly collects information and transmits information to attackers without the user's knowledge

Protection Scheme: firewall, anti-virus, Intrusion Detection/Protection Scheme

(iii)

ensure the servers are up-to-date and equipped with protection schemes; keep the confidentiality and the safety of the emails from the clients; constantly upgrade their knowledge and skills

### **Question 4**

(a) Recursion means a function that is defined in terms of itself; a function that calls a simpler version of itself

(b) Each time when the function SEQ is called, an activation record is generated including its **parameter n, return value and return address**. This activation record is **pushed** onto the run-time stack. When a recursive version of SEQ terminates, its activation record is **popped** from the stack. The **top** activation record in the stack is always the procedure currently executed.

(c) line 05

(d) `return n + 1`

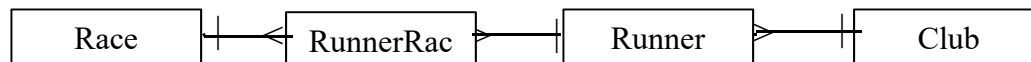
### **Marker's Comment:**

Part (b) is poorly done. Many students did not explain the key features of stack (push, pop, top) clearly. We shall use the term PUSH and POP instead of any other words.

**Question 5** (a) Yes. All cells in the table has atomic values

(b) Not in 3NF. There are transitive dependencies in RunnerClub table.  
ClubName, ClubTel is transitive dependent on RunnerID.

(c)



(d)

Race(RaceDate, RaceDistance)  
Runner(RunnerID, RunnerName, ClubID)  
Club(ClubID, ClubName, ClubTel)  
RunnerRace(RunnerID, RaceDate)

(e)

```
SELECT Runner.RunnerName, Club.ClubName
FROM RunnerRace INNER JOIN Runner ON RunnerRace.RunnerID = Runner.RunnerID
INNER JOIN Club ON Runner.ClubID = Club.ClubID
WHERE RunnerRace.RaceDate = '20-03-2022'
ORDER BY Runner.RunnerName DESC
```

(f) Existing table design supports one race per day hence it is possible to **use the column RaceDate as an unique identifier for the record in the table**. With the cancellation of the agreement, it would mean that there could be **one or more races on the same day**, this will mean that the **column RaceDate is not able to uniquely identify the record**.

Two tables need to be changed.:

- Race(RaceID, RaceDate, Race Distance)
- RunnerRace(RunnerID, RaceID)

(g) Any 2 of the 9 – describe the actions to be done

1. Under Consent Obligation -Only collect, use or disclose personal data when an individual has given his/her consent.
2. Under Purpose Limitation Obligation - An organisation may collect, use or disclose personal data about an individual for the purposes that a reasonable person would consider appropriate in the circumstances and for which the individual has given consent.
3. Under Notification Obligation - Notify individuals of the purposes for which your organisation is intending to collect, use or disclose their personal data on or before such collection, use or disclosure of personal data.

4. Under Access and Correction Obligation - Upon request, the personal data of an individual and information about the ways in which his or her personal data may have been used or disclosed in the past year should be provided. Organisations are also required to correct any error or omission in an individual's personal data upon his or her request.
5. Under Accuracy Obligation - Make reasonable effort to ensure that personal data collected by or on behalf of your organisation is accurate and complete, if it is likely to be used to make a decision that affects the individual, or if it is likely to be disclosed to another organisation.
6. Under Protection Obligation - Make security arrangements to protect the personal data that your organisation possesses or controls to prevent unauthorised access, collection, use, disclosure or similar risks.
7. Under Retention Limitation Obligation - Cease retention of personal data or remove the means by which the personal data can be associated with particular individuals when it is no longer necessary for any business or legal purpose.
8. Under Transfer Limitation Obligation - Transfer personal data to another country only according to the requirements prescribed under the regulations, to ensure that the standard of protection provided to the personal data so transferred will be comparable to the protection under the PDPA.
9. Under Accountability Obligation - Make information about your data protection policies, practices and complaints process available on request.

***Marker's Comments:***

Some students did not realise, based on the data given, there is no relationship between Club and Race:

ClubID =1 and Race=20-03-2022, ClubID=2 and Race=20-03-2022

ClubID =1 and Race=15-02-2022, ClubID=3 and Race=15-02-2022

Some students did not realise, based on the data given, there is relationship between Runner and Race:

RunnerID =1 and Race=20-03-2022, RunnerID =2 and Race=20-03-2022

->One race has many runner

RunnerID =1 and Race=15-02-2022,

->one runner participate in many races

Some students include attributes in ERD. Attributes should not be part of the ERD.

For SQL statements, use single quotation marks. Eg racedate='20-03-2022'

**Question 6**

(a) A binary search algorithm should be used instead as the list is sorted chronologically. It would be a more efficient method as the time complexity is  $O(\log n)$  compared to  $O(n)$  if a linear search was used.

(b) A hash key is used to find a location in a Hash Table to search for or store data. The worst case scenario time complexity for hash table search is  $O(n)$ .

(c) This method of finding a hash key is simple. (advantage) However, as most diagnosis would happen in the day time, during the working hours of clinics and hospitals, most of the data would

be clustered within a certain range of the hash table, leading to higher chances of collision. (disadvantage)

(d) 2 possible methods are chaining and linear probing. Chaining is the better strategy.

Chaining is a better option as it would allow better tracking of trends. Linear Probing would also have a huge disadvantage of having a record stored at a time that is not related to the person who was diagnosed. For example, if 24 people were diagnosed in the same hour, the 24<sup>th</sup> person would be stored in a record that is 1 full day away.

Linear Probing is also not as good as linear probing may result in skipping certain hash keys, leading to a breakage in the “links” or breakage of the “contact tracing”, which may be better tracked if chaining was used.

***\*Marker’s Comments:***

(b) Most students understood that a hash key is derived from a hash function, but many then failed to give an explanation as to how it could be used.

(c) Some students incorrectly interpreted this as to give one advantage of using the hash key, rather than the method of generating the hash key.

**Question 7**

(a) 1101

(b)

```
FUNCTION INV(BIN_STR) RETURNS STRING
###  RET_STR ← ''
      FOR INDEX ← 0 TO 3
        IF BIN_STR[INDEX] = '0'
          RET_STR ← RET_STR + '1'
        ELSE-IF BIN_STR[INDEX] = '1'
          RET_STR ← RET_STR + '0'
      RETURN RET_STR
ENDFUNCTION
```

(c) Line 7 is the line adding the bits from num1 and num2 and any carry-over value. Lines 8 determines that if the value is at most 1, then there would be no need to carry over. (line 9) Otherwise, in lines 10-12, the value is at least 2 and cannot be represented in 1 bit, so a carry bit is added and the value reduces by 2.

(d) add(bit2, inv(bit4))

(e) 4 + 4 should give 8. However, 8 can not be defined 4bit by one’s complement. Hence, 8 is considered to be too big, and it ‘overflows’ to return a smaller/negative value. (in this case, it returns 1000 which has a value of -7)

***\*Marker’s Comments:***



(b) Note that Python function `range` and code `for char in aString` are not considered as pseudocode. To explain traversal in the string with pseudocode, we will make use of the index.

```
FOR index = 1 TO LENGTH(bin_str)
    <statements using bin_str[index]>
ENDFOR
```

(c) Many students gave descriptions of line 07-12, but failed actually to state that the value is the sum of the bits from `num1` and `num2`, and also the carry bit.

(e) For 1's complement, the range of  $n$ -bit numbers that can be represented is from  $-(2^{n-1}-1)$  to  $+(2^{n-1}-1)$ .

The table below shows all possible values in a 4-bit system, from  $-7$  to  $+7$ .

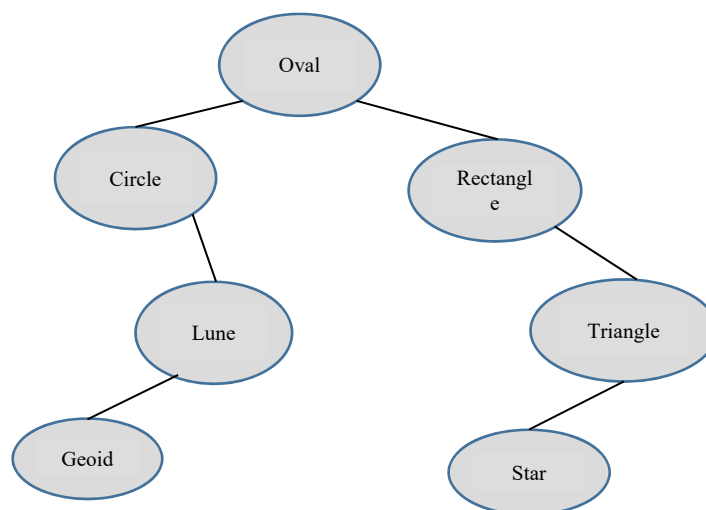
4-bit	0000	0001	.....	0110	0111	1000	1001	.....	1101	1110	1111
1's complement	+0	+1	.....	+6	+7	-7	-6	.....	-2	-1	-0

For the `add()` function, miscalculation may occur when two 4-bit 1's complement numbers are added and the result cannot fit into that 4-bit group. (i.e. if `result > +7` (overflow) or `result < -7` (underflow) or there is a carry from the most significant bit)

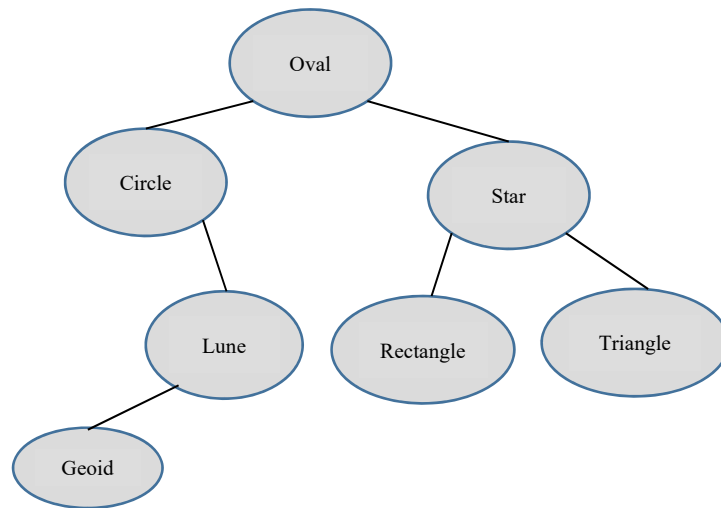
## Question 8

(a) Oval, Circle, Arbelos, Lune, Square, Rectangle, Triangle, Star

(b)



Or



(c) 

```

FUNCTION InOrder(root)
  IF root <> None
    InOrder(root.left)
    OUTPUT root.data
    InOrder(root.right)
  ENDIF
ENDFUNCTION

```

(d) 

```

FUNCTION Search(root, target)
  IF root = None
    RETURN False
  ELSE-IF target < root.data
    RETURN Search(root.left, target)
  ELSE-IF target > root.data
    RETURN Search(root.right, target)
  ELSE
    RETURN True
  ENDIF
ENDFUNCTION

```

**\*Marker's Comments:**

(c, d) Many students did not have a base case to check if the tree is empty, to stop the recursion.

(d) The function definition said it will return a Boolean value, so need a return statement when the recursive function is called. E.g. return Search(tree.left, target). Without the 'return', it simply returns None instead of the result.