Software Design and Architecture (SE2002)

Final Exam

Sections: ALL

Date: May 29th 2024

Total Time: 3 Hours
Total Marks: 70
Weight: 40%
Total Questions: 07

Course Instructor(s)
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Student Name   Roll No   Section   Student Signature

Instructions: Attempt all questions on the question paper.

Neither use nor submit any extra sheet.

Question 7 has two versions – one for sections BSE-4A &
BSE-4B and the other for sections BSE-4C & BSE-4D.
Attempt the version relevant to your own section.

CLO 4: Use different UML notations for software design

Q1 .... **[10]**

You are developing a digital pet that can interact with the user. The pet can be **happy, sad, sleeping**, and **hungry**. The pet starts happy. Leaving the pet alone for 20 minutes makes it sad. Playing with the pet makes it happy again. Not feeding the sad pet for 10 minutes makes it hungry. Feeding a hungry pet makes it happy. Putting a happy pet to sleep transitions it to sleeping. A pet wakes up naturally from sleeping after some time as happy.

Create a state diagram to model the pet. The state diagram must include events that are responsible for transitioning from one state to another. You must use only four states highlighted in bold.

Solution:
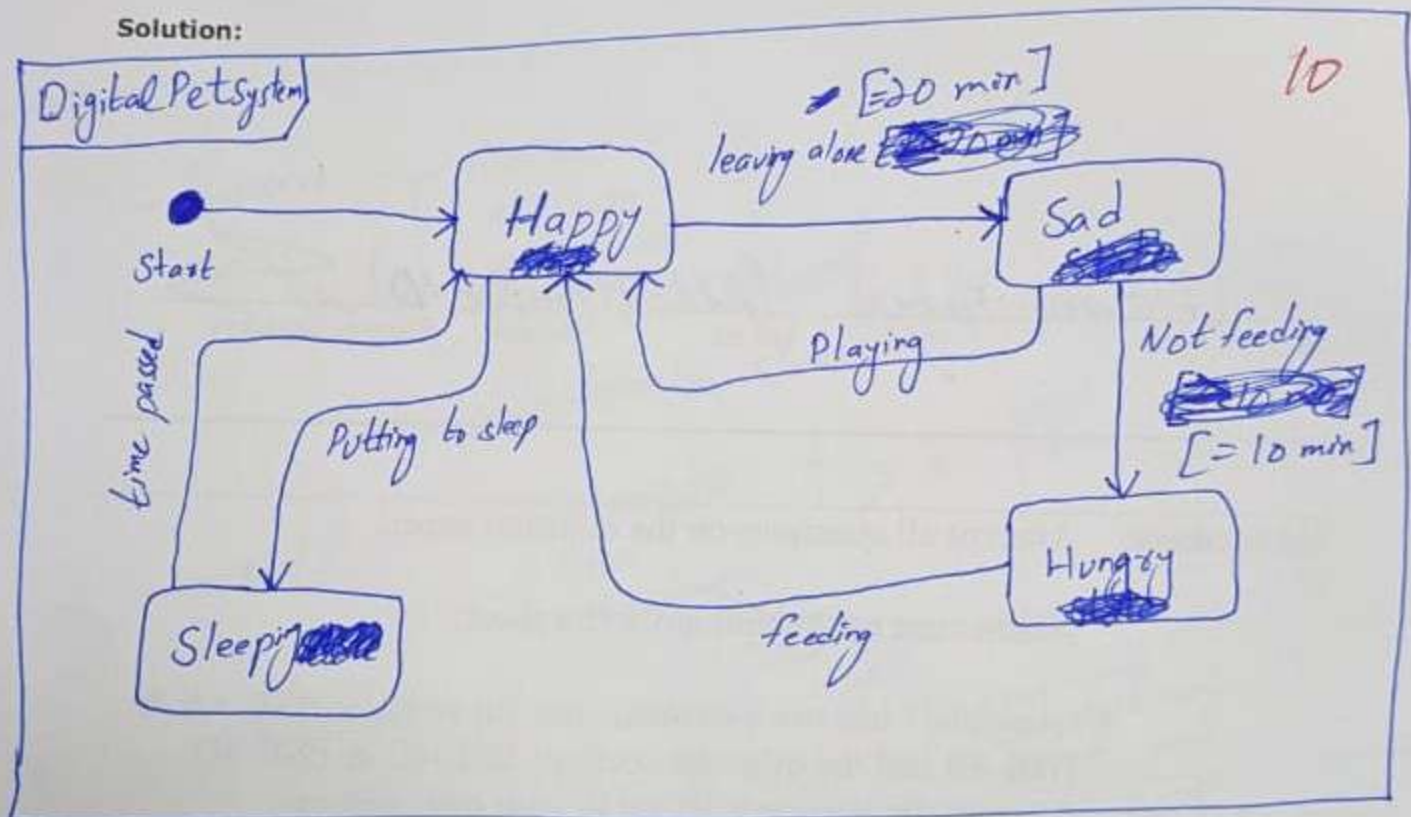
These was no mention of an end state, represented by ⊙.

CLO 3: Implement object-oriented principles for software analysis and design

Q2 .... [10]

You are working on a graphics application that can draw various shapes including circle, and rectangle. You have discovered a modern library that can draw lines very efficiently. You want to utilize modern line drawing techniques implemented by the new library. The code for your existing application and the modern library is provided. Create an adapter class that will allow your library to utilize the modern library. You want to draw the rectangle using the efficient line drawing method in the modern library. You must provide complete Java code of the adapter class including its constructor and any overridden method.

```java
public class GraphicsLibrary {
    public void drawCircle(int x, int y, int radius) {
        // Code to draw a circle
    }
    public void drawRectangle(int x, int y, int width, int height) {
        // Code to draw a rectangle
    }
}
```

```java
public class ModernGraphicsLibrary {
    void drawLine(int x1, int y1, int x2, int y2) {
        // Efficient code to draw a line
    }
}
```

Using this code as base

Solution:

(handwritten, struck-through) ~~public class ModernGraphicsLibrary void drawLine(int x1, int y1, int x2, int y2) // Efficient code to draw line~~ → It is an overridden function.

```java
public class Adapter extends GraphicsLibrary {   // old graphics object.
    public ModernGraphicsLibrary mgl;

    @Override
    public void drawRectangle(int x, int y, int width, int height) {
        mgl.drawLine(x, y, width, height);
        mgl.drawLine(x, y, width, height);
        mgl.drawLine(x, y, width, height);
        mgl.drawLine(x, y, width, height);
        // this draws all 4 sides & more changes
        // can be added here.
    }

    public Adapter() {
        this.mgl = new ModernGraphicsLibrary();
    }
}
```
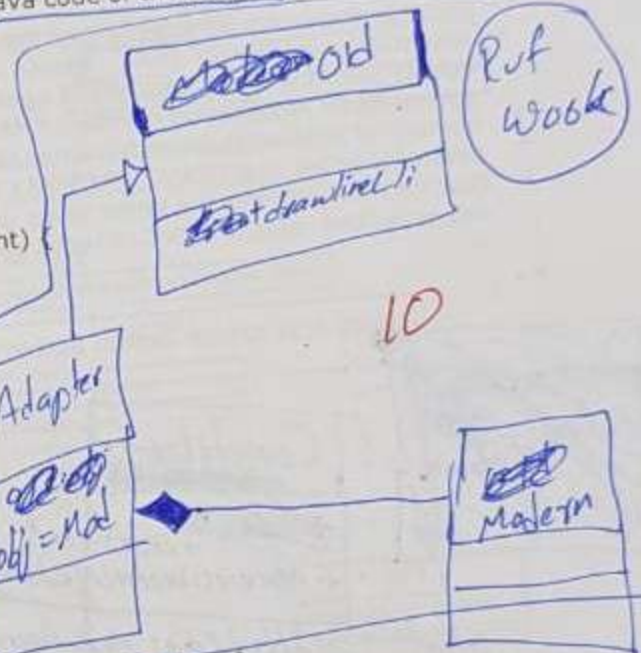
No override this code *(struck through)*

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```
for(int i=0; i< agencies.size();i++)
{
    agencies[i]→update();
}
```

Sorry about the cutting & bad handwriting

CLO 3: Implement object-oriented principles for software analysis and design

cout<<"NAVC has changed to"<<
NAC.NAVC;

Q3 .... [10]

Map the information given below to a **UML 2 design class diagram** that uses the most **appropriate design pattern**. Annotate your diagram (drawn inside the box) with important comments containing error-free C++ code. Realistic and relevant assumptions may be made where necessary.
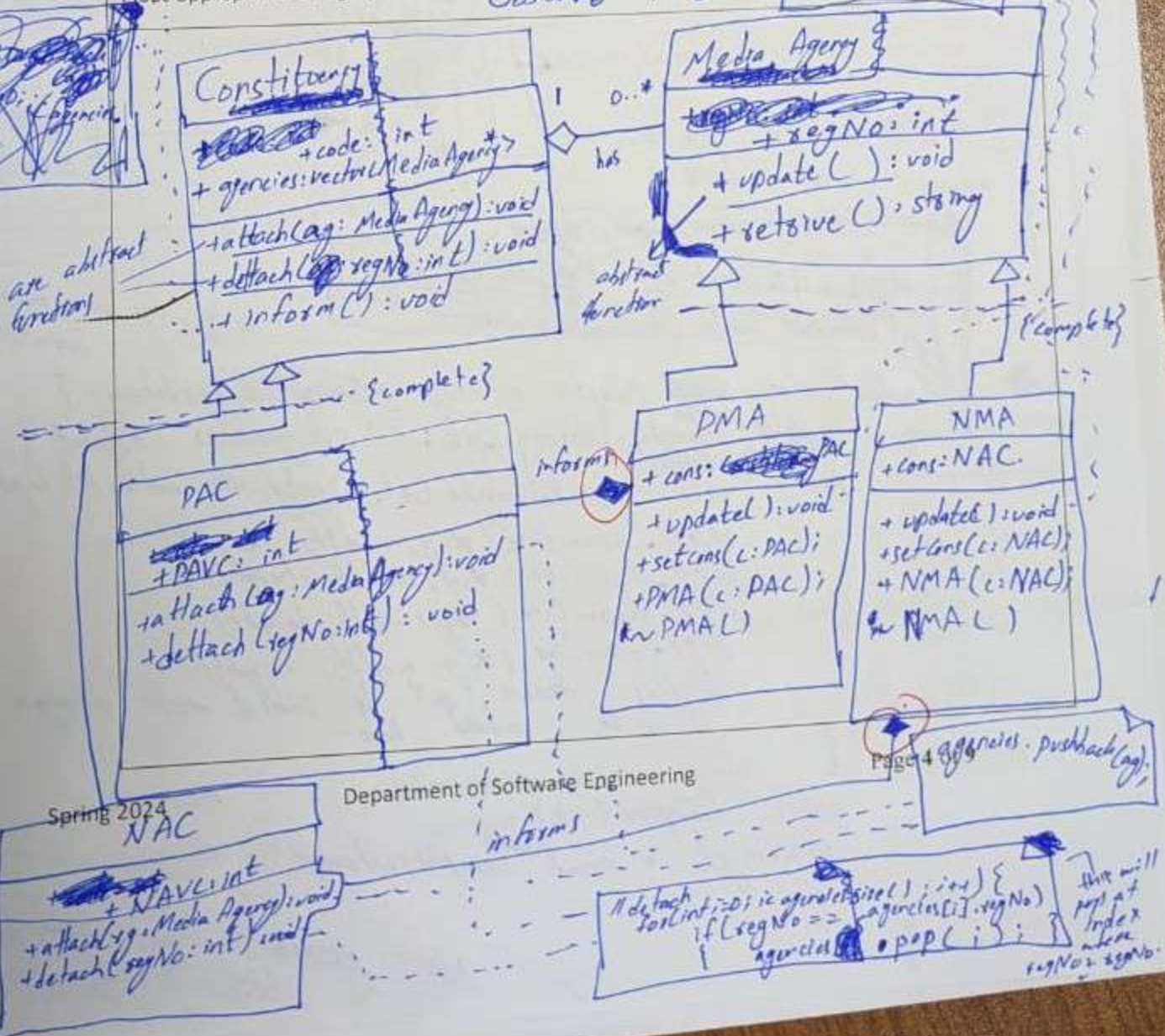
<u>Note: No credit will be given in case of failure to identify the most appropriate design pattern.</u>

Constituencies are of exactly two type i.e. provincial assembly constituency (PAC) and national assembly constituency (NAC). Media agencies are also of exactly two type i.e. provincial media agency (PMA) and national media agency (NMA). Every constituency has a code and every media agency has a registration number. PMAs follow PACs while NMAs follow NACs. A PAC maintains the number of provincial assembly votes cast (PAVC) while an NAC maintains the number of national assembly votes cast (NAVC). All PMAs must be informed whenever the value of PAVC changes so that they can retrieve the latest value of PAVC and publish it. Similarly, all NMAs must be informed whenever the value of NAVC changes so that they can retrieve the latest value of NAVC and publish it.

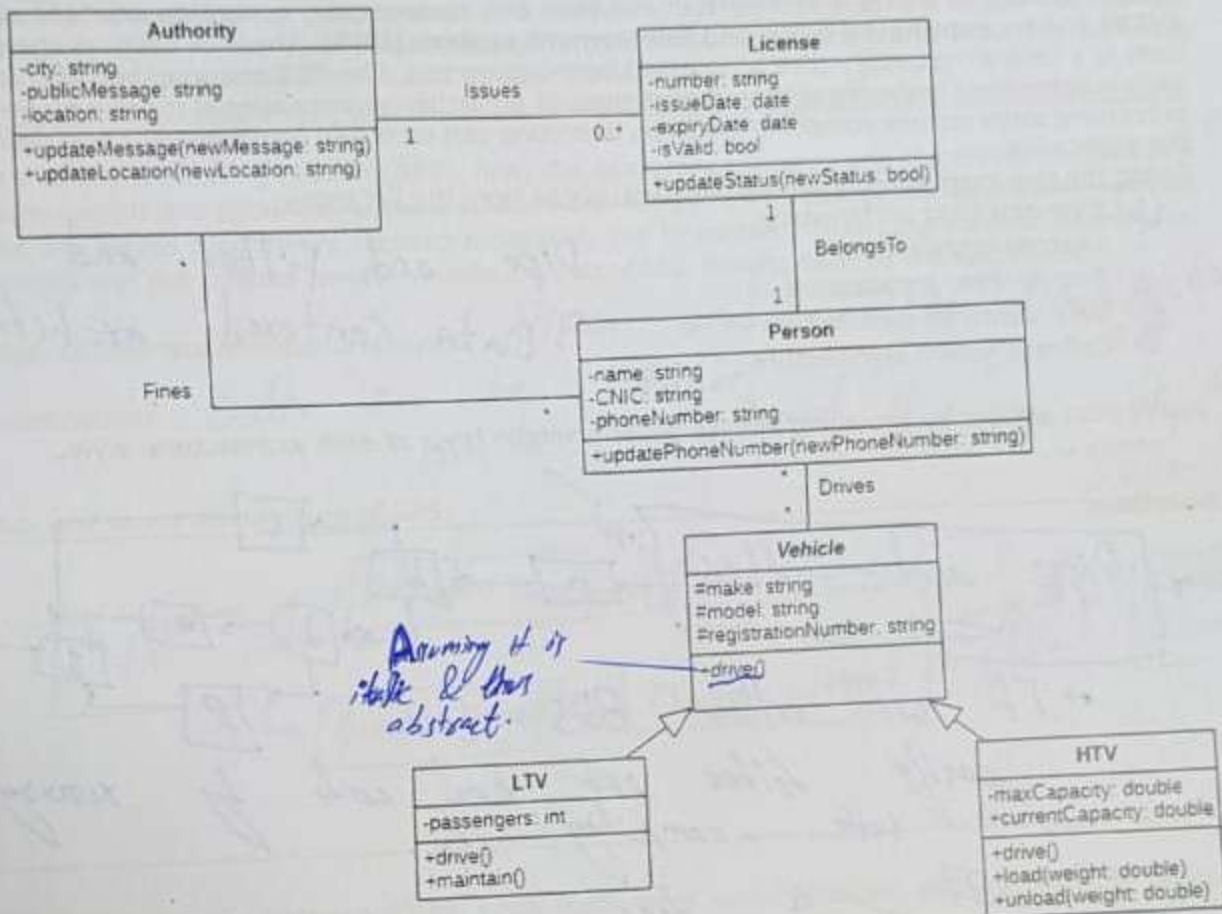Most appropriate design pattern: **Observer Pattern.**

cout<<"PAVC has changed to"<<
PAC.PAVC;

Constituency
+code: int
+ agencies: vector<Media Agency>
+attach(ag: Media Agency):void
+dettach(regNo:int):void
+inform():void

are abstract functions

Media Agency
+regNo: int
+ update(): void
+retrieve(): string

abstract function

{complete}

PAC
+PAVC: int
+attach(ag: Media Agency):void
+dettach(regNo:int): void

informs

PMA
+cons: PAC
+update():void
+setcons(c: PAC);
+PMA(c: PAC);
~PMA()

NMA
+cons: NAC
+update():void
+setcons(c: NAC);
+NMA(c: NAC);
~NMA()

{complete}

agencies.push_back(ag);

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NAC
+NAVC: int
+attach(ag: Media Agency):void
+detach(regNo: int):void

informs

//detach
for(int i=0; i<agencies.size(); i++){
  if(regNo == agencies[i].regNo){
    agencies[i].pop();
  }
}

this will put at index

regNo=regNo.

CLO 1: Describe software design guidelines and principles

Q4 .... [10 = 1 x 10]

Without making any assumptions, use the information provided in the design class diagram above to determine the values of the OO metrics for the classes specified in the table below. Use 2 decimal places for non-integer values.

S#	Class	Metric (Abbreviation)	Value
1	License	Class Size (CSize)	5 (4 attributes + 1 method)
2	LTV	Class Size (CSize)	3 + ~~attributes~~ 1 attribute +2 method
3	HTV	Class Size (CSize)	5 x (2 +3).
4	LTV	Specialization Index (SI)	0.5 or 1/2
5	HTV	Specialization Index (SI)	1/3
6	Vehicle	Depth of Inheritance Tree (DIT)	0 for vehicle but 1 for LTV & HTV.
7	Vehicle	Number of Children (NOC)	2
8	Authority	Weighted Methods per Class (WMC)	2
9	Person	Coupling Between Objects (CBO)	3
10	Vehicle	Coupling Between Objects (CBO)	3

Rvf Work

$$SI = \frac{NOO \times Depth}{NO}$$

NOO = No of overriden operations

NO = No of Operations (Total).

$$SI (LTV) = \frac{1 \times 1}{2} = \frac{1}{2} = 0.5$$

$$SI (HTV) = \frac{1 \times 1}{3} = \frac{1}{3}$$

CLO 2: Explain different software architecture styles

Q5 .... **[10]**

You are tasked to create a system that will have two components, a **version control system (VCS)** and an **automated build and deployment system (BDS)**. The VCS holds all the source code in a central repository that is accessed by programmers. The BDS ensures that when source code is committed in the repository, it goes through a number of processing steps one by one. The processing steps include compiling the code, executing unit tests and finally building and deploying the application.

Select the two most appropriate architectural styles from the list below:
1. Pipe-and-filter architecture
2. Layered architecture
3. Peer-to-Peer architecture
4. Data Centered architecture
5. Call and Return architecture

Pipe and Filter and
Data Centered architecture.

Justify your answer by providing precise bullet points in favor of each architectural style.

Solution:

Pipe and Filter:
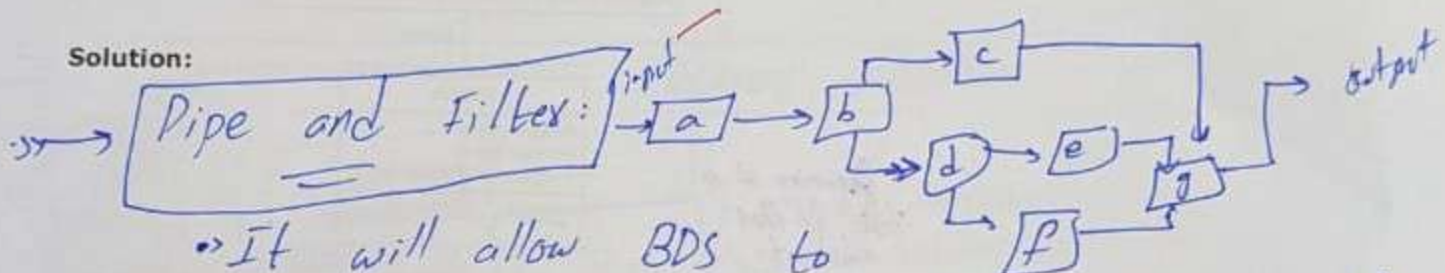
> • It will allow BDS to easily filter out bad code by running unit tests, compiling etc.
> • It is done step by step so if an error is detected it will be prevented from the next steps.

Data Centered architecture:
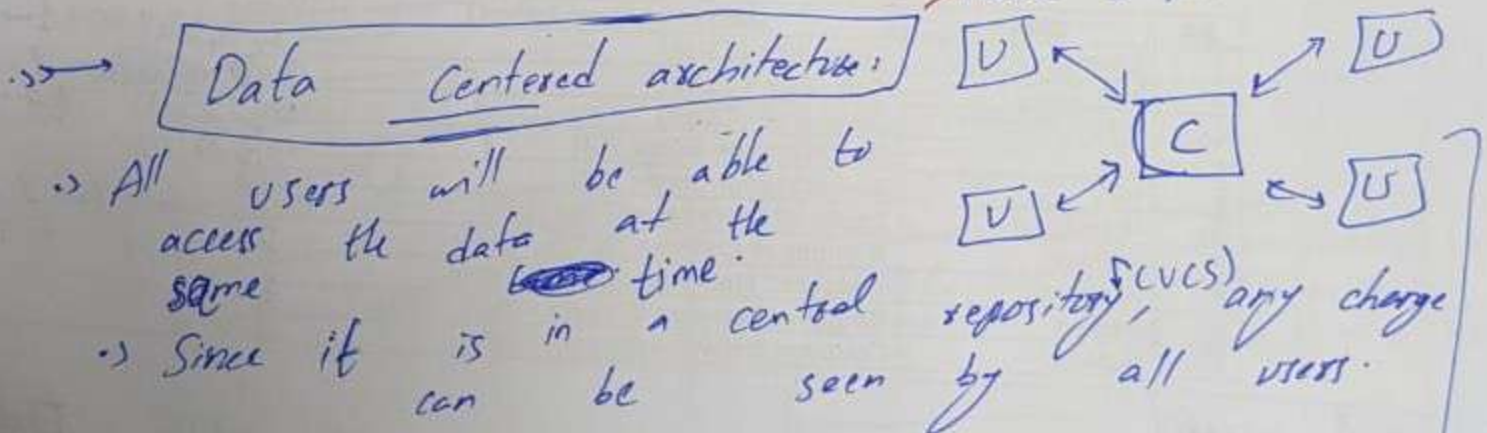
> • All users will be able to access the data at the same time.
> • Since it is in a central repository (CVCS), any change can be seen by all users.

> • It is bi-directional so, data can be inputted and outputted.

C is central
data and U are
users.
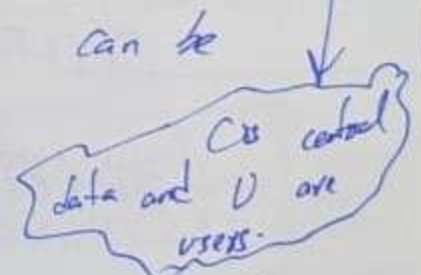
10

CLO 5: Design architecture of a software system by choosing the most appropriate architecture styles

Q6 .... [10 = 5 + 5]

For each of the following descriptions of a software system, choose the most appropriate architectural style, justify your choice (using not more than 20 words), and draw the software system's architecture using the box and arrow notation.

Note: No credit will be given in case of failure to identify the most appropriate architectural style.

eg: image processor.

a. In a salary processing system (SPS), first, the attendance records and the leaves records of a given month are obtained, in parallel, from the HR system. Second, the attendance records and the leaves records are cleaned separately but in parallel. Third, the cleaned attendance records and the cleaned leaves records are reconciled. Finally, salaries are calculated.
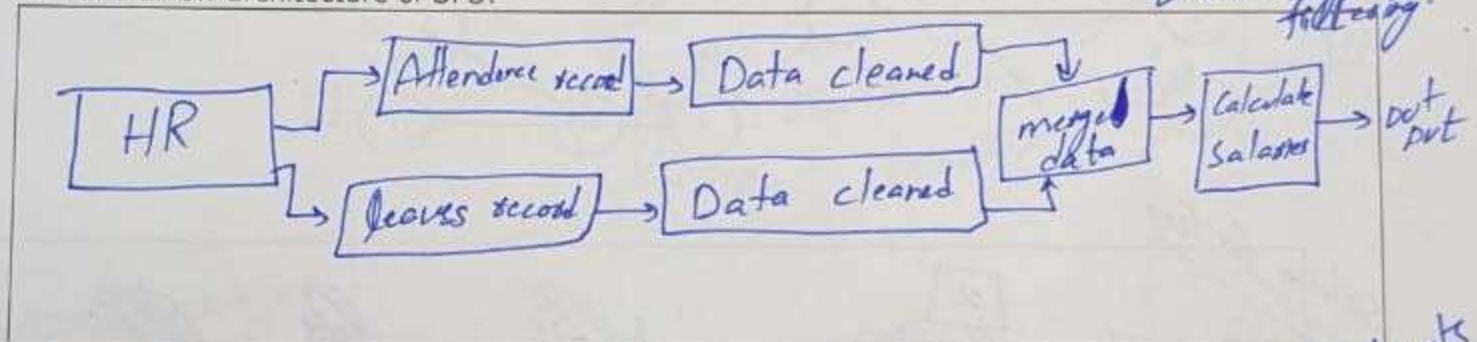
Most appropriate architectural style: **Pipe and Filter Architecture**

Justification: **Data can be taken be can be performed in parallel, steps can be finally merged. Also, it allows for filtering.**

Box and arrow architecture of SPS:

b. In a code sharing platform (CSP), each node owns some (but not all) part of code. Nodes request each other to access the parts of code they need but do not own.
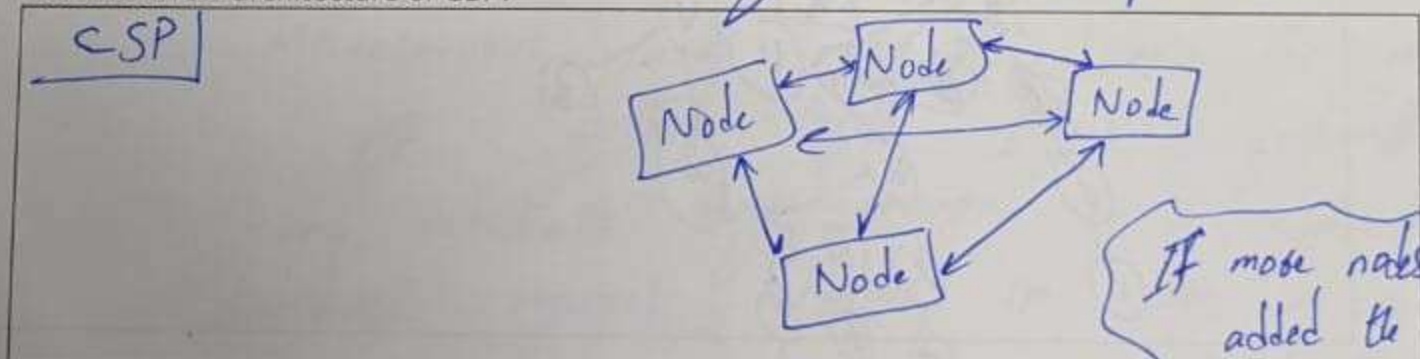
eg: torrents

Most appropriate architectural style: **Peer to Peer Architecture**

Justification: **Each node has the ability to communicate with other nodes & the bidirectional ability of Peer to peer helps.**

Box and arrow architecture of CSP:

If more nodes are added the no of arrows will increase.

CLO 5: *Design architecture of a software system by choosing the most appropriate architecture styles*
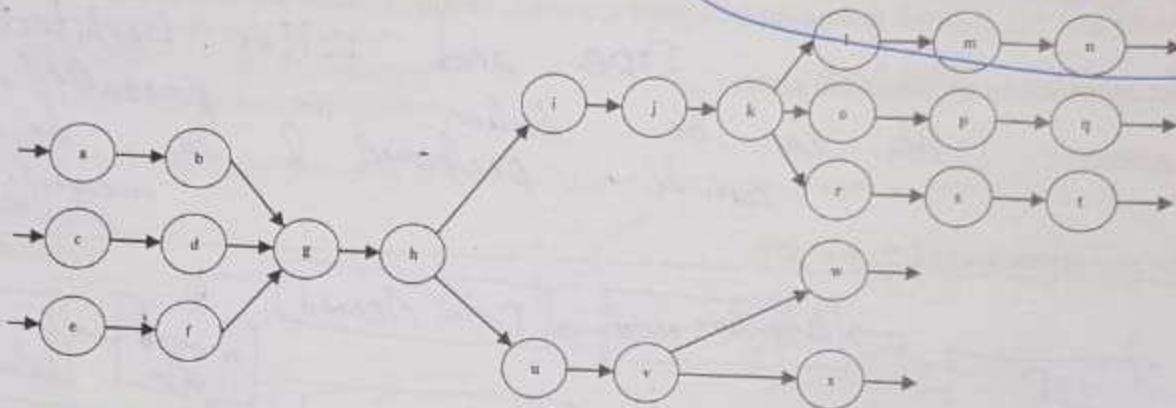
Q7 ....[For Sections (BSE-4A, BSE-4B)]... [10]

The following diagram shows the complete lowest level DFD of an e-commerce system. Use structured design to derive the call-and-return program architecture from this DFD. Only the final (i.e. most optimized) architecture is required.
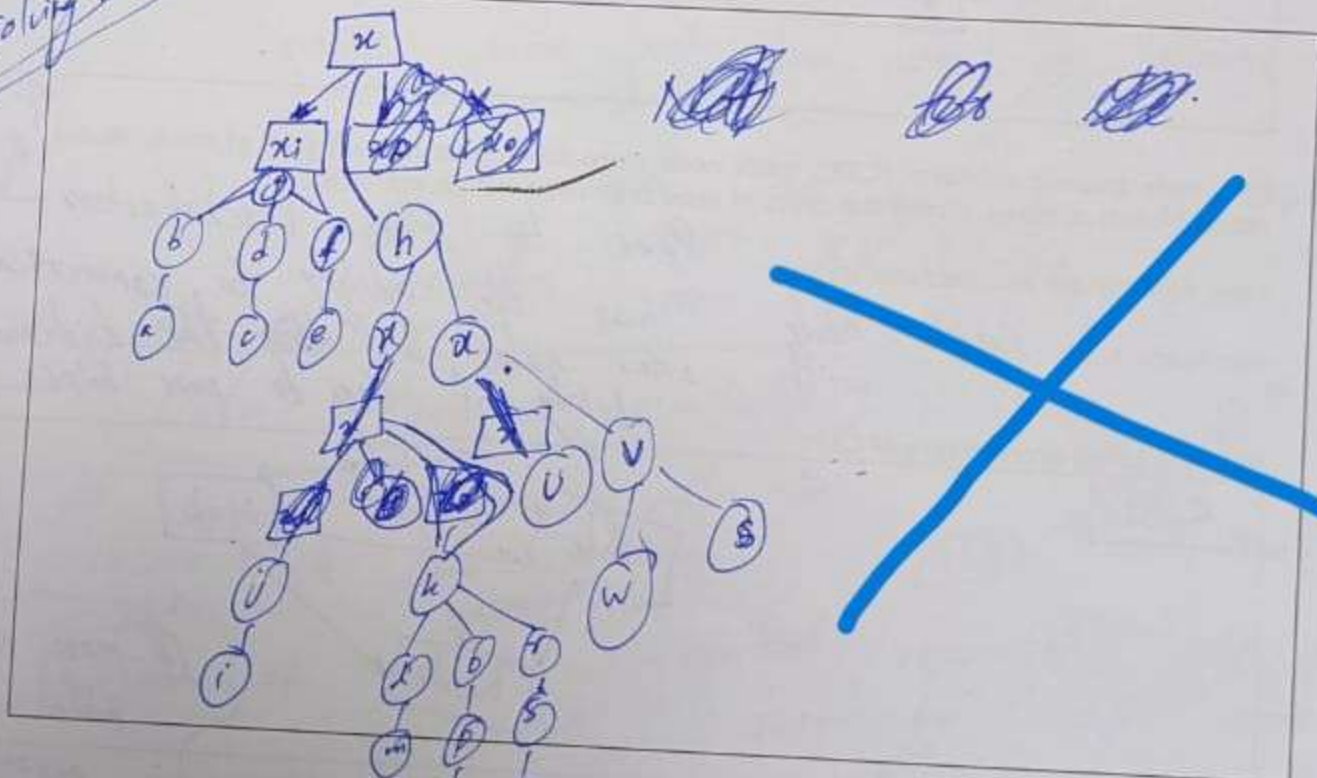
The following information should be used for mapping:
- 3 Transform centers: 'm'; 'p'; 's'.
- 3 Transaction centers: 'h'; 'k'; 'v'.

I am in BSE-4B, not in A or B.

Solving for full

CLO 5: Design architecture of a software system by choosing the most appropriate architecture styles

Q7 ....[For Sections (BSE-4C, BSE-4D)]........................ [10]

What are the **most important** advantages and disadvantages of a microservices architecture? Provide two bullet points for each.

Solution:

⟶» **Advantages:**

- Microservice Architecture can provide easy endpoints for other apps to communicate with it. to

- It can easily allow for parallel and concurrent requests.

- It can easily scale up to handle more traffic.

⟶» **Disadvantages:**

- If any change is made in the microservice endpoint, Applications that are still using the old system, need time to adjust to the new system (by changing their code).

- Microservices are sub-modules for a large central system and database. Any change in system or database requires changes in the micro-service endpoints (such as APIs, so that they can easily communicate with central system.