

Object-oriented Analysis & Design (Fall 2012)

Total Marks : 50

Time: 3 hrs

Consider the following system description:

ABC Service delivers drinking water and periodicals to customers. The company sells different brands of water: Nestle, Aqua and Sufi, etc. And it sells two types of periodicals: newspapers and magazines. The newspapers include Dawn, Jang and Nation, etc., while magazines include Herald and Akhbar-e-Jahan, etc.

Customers can request to subscribe/unsubscribe the service by using an online system (website). An administrator approves/disapproves these requests by considering different parameters such as location/area.

A customer can search and subscribe to one or more products, and can specify the quantity required, for example 2.5 litre of water, or 2 copies of a particular newspaper, etc. He also specifies the duration of subscription. At the time of subscription, customer shall be shown subscription amount (total as well as item-wise details). Customers can also see their subscription history.

Company also provides some bundled subscription deals, which offer a discount as well. For example, Dawn and Herald can be bundled into a deal. There is no restriction on the type and number of items that can be bundled. The subscription amount of a bundle is the sum of amount of all items that are part of bundle minus the discount.

Every product has some associated attributes: for example a newspaper has its editor, number of pages, etc. Water has its nutrients, expiry date, etc. The customer may like to view such details for any product.

The system does not handle payments: neither it provides online payment facility nor it records any monetary transactions.

Answer the following:

1. Give a use case diagram for the system. **(10 marks)**
2. Give a detailed class diagram showing important attributes, methods and relationships. **(20 marks)**
3. Give a use case description for the following use case: "Place a request for subscription". Your description should be precise and concise. **(10 marks)**
4. Give a sequence diagram to show how the above use case will be implemented using your proposed design . **(10 marks)**

Object-oriented Analysis and Design

Final, Spring 2014

Date: May 17, 2014

Marks: 70

Time: 180 mins.

Note: Please read the case and then answer the questions on next page

Consider a web application to create a discussion forum (e.g. Stack Overflow, Code Guru, etc.). A forum software allows you to create and manage forums and posts, so that users can participate in discussions and learn from each other. The features it provides can be summarized as under:

1. An authorized user (e.g. Admin) can create a forum. A forum is a collection of topics that may be categorized as required. For instance, Code Guru has several forums e.g. C++ Programming, Graphics Programming, Network Programming, etc. Each forum has topics that can be categorized, for instance, under C++ forum there may be several topics related to C++ programming that can be sorted into categories such as: General C++ discussion, GUI programming, etc. Each category may have as many sub-categories as desired.
2. Any registered user can initiate a topic. A topic is a message posted on the forum in order to ask a question or start some discussion. Other registered users can then post replies to the topic (to answer questions or participate in the discussion)
3. Before a message is posted, it can be saved in a draft state. A draft shows that the message is still under construction and may not be complete. Draft message does not appear on the forum but its author can still edit its contents. Only when the message is posted, it appears on the forum.
4. Anybody can read the topics or replies on any forum. There is no registration requirement for that.
5. Moderators may be appointed for some forums whose responsibility is to remove or edit unwanted content and keep the discussion focused. A user may be a moderator for one forum and not for the other.
6. Users can subscribe to alerts. For instance, a user may select an option to be notified through email whenever a new message is posted on a specific topic.
7. Moderators may also specify restrictions. For instance, moderator may set conditions that any message posted in a particular forum/category/topic will be first approved by the moderator. Such posts will be placed in the moderation queue first and not shown on the forum until they are approved. Moderator may also opt for an email notification on posting of such messages.

Object-oriented Analysis and Design
Final, Spring 2014

Date: May 17, 2014

Marks: 70

Time: 180 mins.

Questions:

1. Identify **use-cases** and show a **use-case diagram** for given requirements. Provide a brief description for each usecase (not more than 3 lines each) (20)
2. Identify design patterns that can be applied to solve this problem. Justify your selection with specific references to the problem statement (i.e. which specific requirements lead to your selection of the pattern and how will that be helpful). Your description should not exceed 5 lines for each pattern. Show a **class diagram** applying relevant design patterns identified above. (30)
3. Provide **sample code** for each pattern to highlight implementation issues in the context of given problem (20)

Object-oriented Analysis and Design

Final Exam, Fall 2015

Date: December 10, 2015

Marks: 90

Time: 180 mins.

Section _____ Roll No. _____ Name _____

Note for Invigilators: Students are allowed to use a single-sided, hand-written, A-4 size help sheet.

Note for Students: Solve the exam on this question paper. Do **not** submit answer sheets.

Question 1 (Max. Marks = 15)

For each of the statements given in the table below, underline either True or False. Think before you underline the correct option. Cutting/scratching will result in disqualification of answer.

S#	Statement	True	False
1	An object has its own value for each attribute but shares the attribute names and operations with other instances of its class.	True	False
2	An implementation of a method by a specific class is called an operation.	True	False
3	Analysis deals with "how" whereas design deals with "what".	True	False
4	State diagrams should be constructed for all classes with meaningful temporal behavior.	True	False
5	The interaction model describes the aspects of an object that change over time.	True	False
6	Abstraction is the selective examination of certain aspects of a problem.	True	False
7	A class model captures the dynamic structure of a system by characterizing the objects in the system, the relationships between the objects, and the attributes and operations for each class of objects.	True	False
8	The term identity means that objects are distinguished by their inherent existence and not by descriptive properties that they may have.	True	False
9	Class diagrams are useful both for abstract modeling and for designing actual programs.	True	False
10	Association is a relationship among at least two classes.	True	False
11	Association end names make it possible to create multiple references of same class.	True	False
12	Aggregation is a form of composition with two additional constraints.	True	False
13	Polymorphism acts as the only basis of reuse in object-oriented applications.	True	False
14	Declaring attributes with class scope leads to inferior design as it is similar to declaring global variables.	True	False
15	Multiplicity constrains the number of related objects.	True	False

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Date: December 10, 2015

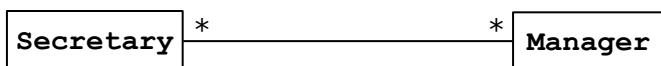
Marks: 90

Time: 180 mins.

Question 2 (Max. Marks = 10 + 5 = 15)

Write C++ code in the space provided to show (compile-time and run-time) error free implementation of following two relationships shown in a UML 2 design class diagrams.

1.



<pre>public class Secretary{ }; void Secretary::add(Manager* m) { }</pre>	<pre>public class Manager{ }; void Manager::add(Secretary* s) { }</pre>
---------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------

Object-oriented Analysis and Design
Final Exam, Fall 2015

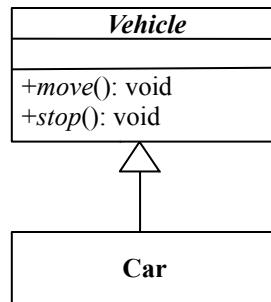
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Time: 180 mins.

Section _____ Roll No. _____ Name _____

2.



// Vehicle code goes here

// Car code goes here

Object-oriented Analysis and Design

Final Exam, Fall 2015

Date: December 10, 2015

Marks: 90

Time: 180 mins.

Question 3 (Max. Marks = 10 + 10 + 10 = 30)

"Rename File" is one of the most important use cases of the FASTFile file management system. Needless to say a file must exist in order to be renamed. Moreover, FASTFile allows only administrators to rename files. When an administrator selects a file to be renamed, FASTFile highlights the selected file. Once the administrator has right-clicked the highlighted file, FASTFile displays a pop-up menu showing the various file operations. After the administrator has selected the "Rename" option, FASTFile makes the name of the file editable. If the administrator presses "Escape" at this point, FASTFile makes the file name uneditable and the use case ends. Typically, the administrator types the new name at this point and presses "Enter". FASTFile first checks whether the file being renamed is open. If the file is open, FASTFile displays "File Open" error message. If the file is closed, FASTFile checks whether the new name has any invalid characters (e.g. ?, ", /, :, <, etc.). If an invalid character is present, FASTFile displays "Invalid Character" error message. If no invalid character is present, FASTFile checks whether the new name matches the name of an existing file. If the new name matches an existing name, FASTFile displays "Name Match" error message. Otherwise, FASTFile updates the file name and the use case ends.

Note: The use case ends after any type of error message is displayed.

Use the information provided above to answer the following three parts of this question.

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Final Exam, Fall 2015

Date: December 10, 2015

Marks: 90

Time: 180 mins.

Section **Roll No.** **Name**

- a. Document the entire "Rename File" use case using the **template** given below.

Identifier			
Purpose			
Priority			
Actor(s)			
Pre-conditions			
Post-conditions			
Typical Course of Action			
S#	Actor Action	System Response	
Alternate Course of Action 1			
S#	Actor Action	System Response	
Alternate Course of Action 2			
S#	Actor Action	System Response	
Alternate Course of Action 3			
S#	Actor Action	System Response	
Alternate Course of Action 4			
S#	Actor Action	System Response	

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Time: 180 mins.

b. Model the entire "Rename File" use case using a UML 2 **swimlane activity diagram**.

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Date: December 10, 2015

Marks: 90

Time: 180 mins.

Section _____ Roll No. _____ Name _____

- c. Model the entire "Rename File" use case using a single system-level UML 2 **sequence diagram**.

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Date: December 10, 2015

Marks: 90

Time: 180 mins.

Question 4 (Max. Marks = 15 + 15 = 30)

Consider an Appointment Scheduling System that facilitates appointment scheduling between a client and a service provider. Service provider specifies the services (s)he offers and the corresponding venue and availability hours for the specific service. Client requests an appointment with the service provider by selecting the service and available time-slots and provides the necessary contact details. System resolves any scheduling conflicts in case multiple clients select the same slot simultaneously. Once the appointment is confirmed, system notifies the client through email. Client may also choose to be notified through SMS while making the appointment. Any subsequent changes in the appointment (e.g. possible rescheduling, cancellation, etc) are also notified accordingly. Service Provider can specify templates (message layouts) for sending Email and SMS notifications. Email template supports rich text editing whereas SMS template only supports plain text.

Use the information provided above to answer the following two parts of this question.

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Final Exam, Fall 2015

Date: December 10, 2015

Marks: 90

Time: 180 mins.

Section _____ Roll No. _____ Name _____

- a. Draw the complete UML 2 design class diagram of the Appointment Scheduling System after incorporating all of the relevant design patterns.

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Marks: 90

Time: 180 mins.

b. Provide complete code containing the proper (error-free) implementation of the UML 2 design class diagram of part a.

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Final Exam, Fall 2015

Date: December 10, 2015

Marks: 90

Time: 180 mins.

Section _____ Roll No. _____ Name _____

//continue writing code here

Object-Oriented Analysis and Design

Final Exam, Spring 2016

Date: May 24, 2016

Marks: 90

Time: 180 mins.

Section _____ Roll No. _____ Name _____

Note for Invigilators: Students are allowed to use a double-sided, hand-written, A-4 size help sheet.

Note for Students: Solve the exam on this question paper. Do **not** submit answer sheets.

Question 1 (Max. Marks = 15)

For each of the questions given in the table below, provide a short (i.e. no more than three words) answer.

S#	Question	Answer
1	Which type of an event in a state diagram is caused by the satisfaction of a boolean expression?	
2	Which UML diagram depicts the behavior of an object?	
3	Which type of use case (UC) cannot be used directly by an actor in a UC diagram?	
4	Which type of UC relationship adds incremental behavior to a UC?	
5	Which of the three models (i.e. class, state, and interaction) describes the static structure of a system?	
6	Which of the three compartments of a class in a class diagram is not included while drawing objects in an object diagram?	
7	Which characteristic distinguishes an object from the other even though two may have identical state?	
8	Which type of feature visibility (access specifier) in a class diagram allows methods of the descendants of the containing class to access those features?	
9	What is an association between two objects of the same type called?	
10	Which type of class cannot contain abstract operations?	
11	Which UML 2 element lets you organize and partition large models so that the readers can more readily understand them?	
12	Which type of patterns are concerned with algorithms and assignment of responsibility between objects?	
13	Which type of patterns use inheritance to describe algorithms and flow of control?	
14	Which type of design patterns describe ways to assemble objects?	
15	Which two major elements of the object-oriented paradigm are used by almost all design patterns?	

Object-Oriented Analysis and Design

Final Exam, Spring 2016

Date: May 24, 2016

Marks: 90

Time: 180 mins.

Section _____ Roll No. _____ Name _____

Question 2 (Max. Marks = 10 + 20 = 30)

Consider the dispense feed use case of an automatic bird feed dispensing system (ABFDS) that automatically dispenses the right bird feed (food and water) upon the press of a button. When the user presses the button, a message is sent to the bird feed controller to dispense feed. The type of feed dispensed depends on three factors i.e. time, temperature, and feed plan. The bird feed controller sequentially retrieves time from the time controller, temperature from the temperature controller, and feed plan from the feed plan controller. During hours of darkness (i.e. between 7 pm and 5 am), only water is dispensed using the water dispenser. Similarly, during day time (i.e. when it is not dark), if temperature is extremely hot (i.e. more than 40 °C) only water is dispensed using the water dispenser. If temperature is not extremely hot during the day time then, first, water is dispensed using the water dispenser. Once the water has been dispensed, the food is dispensed using the food dispenser. The type of food dispensed by the food dispenser depends on the feed plan. If the feed plan is set to "frugal", seeds are dispensed by the food dispenser after retrieving them from the seed tray. Otherwise, the food dispenser sequentially dispenses one fruit retrieved from each fruit tray.

Without making any assumptions, use only the information provided above to answer the following two parts of this question.

Object-Oriented Analysis and Design
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- a. Model the dispense feed use case using a UML 2 **swimlane activity diagram**.

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Marks: 90

Time: 180 mins.

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b. Model the dispense feed use case using a single detailed design-level UML 2 **sequence diagram**.

Object-Oriented Analysis and Design

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Date: May 24, 2016

Marks: 90

Time: 180 mins.

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Question 3 (Max. Marks = 20 + 10 + 10 + 5 = 45)

Consider FASTGift - a web application used to send gifts to your contacts on occasions like birthdays, etc. Application provides a list of gift items that can be sent, such as flowers, cakes, etc. Each gift item has a price. Some gift items are bundle items that combine multiple items into a single item and are offered at a discounted price (e.g. both flowers and cake in a single bundle). Price of a bundle item is the sum of price of all the constituent items, less the discount (specified in percentage). A customer places an order and includes as many items as desired. For each item ordered, quantity needs to be specified. Before the order is placed, application calculates the total order price, taking into account each gift item and its ordered quantity. After the order is placed, both the customer and order fulfillment staff are notified. Customer is notified through email. Order fulfillment staff is notified through a special GUI that lists all pending orders in a First-In-First-Out queue.

- a.. Using only the information provided above, develop a complete design-level class diagram of FASTGift by using the following abstractions: Bundle, Customer, Email, GiftItem, Order, OrderItem, and OrderQueue. Your design class diagram must show all relevant attributes, operations, and relationships. It is compulsory to use and explicitly mention all relevant design patterns in your design class diagram (you may add additional classes for this purpose).

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Marks: 90

Time: 180 mins.

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b. Write complete C++ code for the Bundle class (assume there is no separate header file).

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Date: May 24, 2016

Marks: 90

Time: 180 mins.

Section _____ Roll No. _____ Name _____

c. Write complete C++ code for the Order class (assume there is no separate header file).

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Marks: 90

Time: 180 mins.

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d. Write complete C++ code for the OrderQueue class (assume there is no separate header file).



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Program:	BS (Computer Science)	Semester:	Fall 2018
Duration:	180 Minutes	Total Marks:	60
Paper Date:	18-Dec-18	Weight	
Section:	All	Page(s):	8
Exam:	Final	Reg. No.	

Instruction/Notes: Solve the exam on this paper. Do not submit answer sheets. You may use rough sheets but those shouldn't be attached.

Question 1

15 points

1. Relate the following design patterns to their respective intent / purpose by matching each entry in the first column to each entry in the second column

Pattern	Intent/Purpose
Composite	Allow creation of families of related objects independent of implementation
Singleton	Let objects observe the behavior of other objects so they can stay in sync
Factory method	Compose objects into tree structures. Let clients treat primitives & compositions uniformly.
Abstract factory	Abstract creational method that lets subclasses decide which class to instantiate
Observer	Ensuring a class has only one instance

2. Relate the following design characteristics to their respective meaning by matching each entry in the first column to each entry in the second column

Characteristic	Description
Cohesion	The degree of interaction between different classes
Coupling	Hides implementation details and provides easy-to-use interface
Abstraction	The characteristic of being easy-to-change
Modularity	The degree of similarity of the constituent parts
Maintainability	Multiple small independent units

3. Select the best option available:

- (a) In a good design, coupling should be:
 - (i) Low
 - (ii) High
 - (iii) Medium
 - (iv) Readable
 - (v) Reusable

- (b) In a good design, cohesion should be:
 - (i) Low
 - (ii) High
 - (iii) Medium
 - (iv) Readable
 - (v) Reusable

- (c) In object-oriented methodology, modular unit of implementation is:
 - (i) object
 - (ii) method
 - (iii) function
 - (iv) class
 - (v) package

National University of Computer and Emerging Sciences, Lahore Campus			
 <p>Course: Object-oriented Analysis & Design Program: BS (Computer Science) Duration: 180 Minutes Paper Date: 18-Dec-18 Section: All Exam: Final</p>	<p>Course Code: CS-309 Semester: Fall 2018 Total Marks: 60 Weight Page(s): Reg. No.</p>	<p>CS-309 Fall 2018 60 8</p>	

- (d) Object can be defined as:
- (i) an entity with a name and state
 - (ii) an entity with a name and behavior
 - (iii) an entity with a state and behavior
 - (iv) an entity with a name, state and behavior
 - (v) √ an entity with identity, state and behavior
- (e) Polymorphism requires the following conditions for implementation:
- (i) overriding, subtyping and static binding
 - (ii) √ overriding, subtyping and dynamic binding
 - (iii) overloading, subtyping and static binding
 - (iv) overloading, subtyping and dynamic binding
 - (v) overriding, subtyping and method binding

Question 2

10 points

Softec is a prestigious event at FAST-NU. A number of different events are held under the Softec umbrella. These include Software Competition, Programming Competition, IdeasXtreme, etc. Numerous participants from various universities and institutes across the country participate and register for these events.

Softec society plans to develop an online registration system for all these events.

Participants can register for multiple events either individually or in teams according to event requirements.

Each event has an associated registration fee that is to be paid manually using a Bank Draft. Registration of participant(s) is confirmed only once the registration fee is received by Softec society.

Some events may have some special requirements for registration. For example, Software Competition requires from the participating team to submit an Abstract of their software at the time of registration. This Abstract needs to be evaluated and approved by a panel of evaluators before the registration is accepted.

Similarly, other events may have their own special requirements

Initially, participants submit their registration application. Once all the registration requirements for the concerning event are fulfilled and registration fee is received, the registration is confirmed.

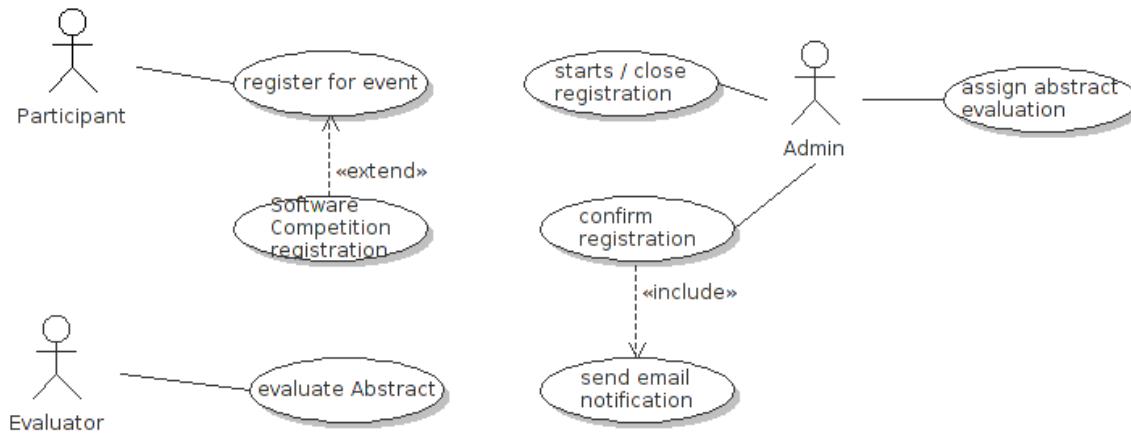
Participants are notified of the confirmation through an email.

National University of Computer and Emerging Sciences, Lahore Campus



Course:	Object-oriented Analysis & Design	Course Code:	CS-309
Program:	BS (Computer Science)	Semester:	Fall 2018
Duration:	180 Minutes	Total Marks:	60
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Develop a use-case diagram for Softec Registration System, illustrating the actors and their respective use-cases. Show important inclusions and extensions, if applicable.



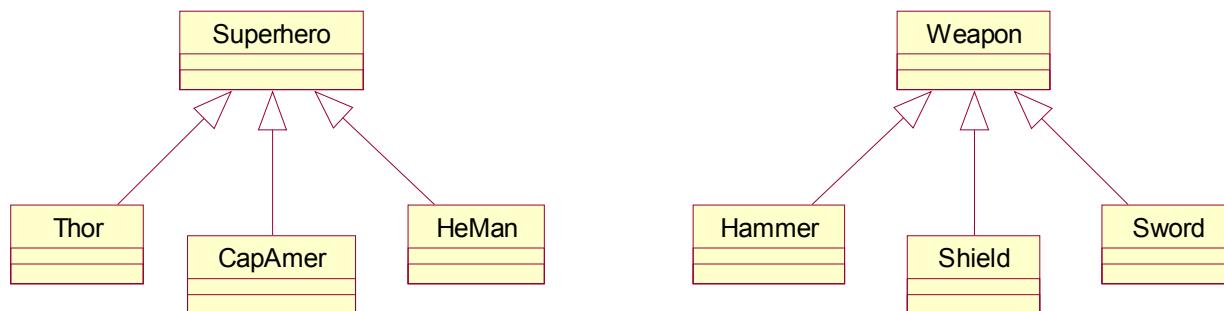


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Question 3

10 points

Consider the following superheroes and their weapons:



The following code assigns a weapon to each superhero:

```

#include <typeinfo>

Weapon* createWeapon(Superhero* ptr) {
    string n = typeid(*ptr).name();
    if (n == "Thor")
        return new Hammer();
    else if (n == "CapAmer")
        return new Shield();
    else if (n == "HeMan")
        return new Sword();
}
  
```

Rewrite / Refactor the above program to improve the program design. If you add any new function(s) during the process then show their code as well.

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```
class Superhero {
public:
    virtual Weapon* createWeapon() = 0;
};

class Thor : public Superhero {
public :
    virtual Weapon* createWeapon() {
        return new Hammer();
    }
};

class CapAmerica : public Superhero {
public :
    virtual Weapon* createWeapon() {
        return new Shield();
    }
};

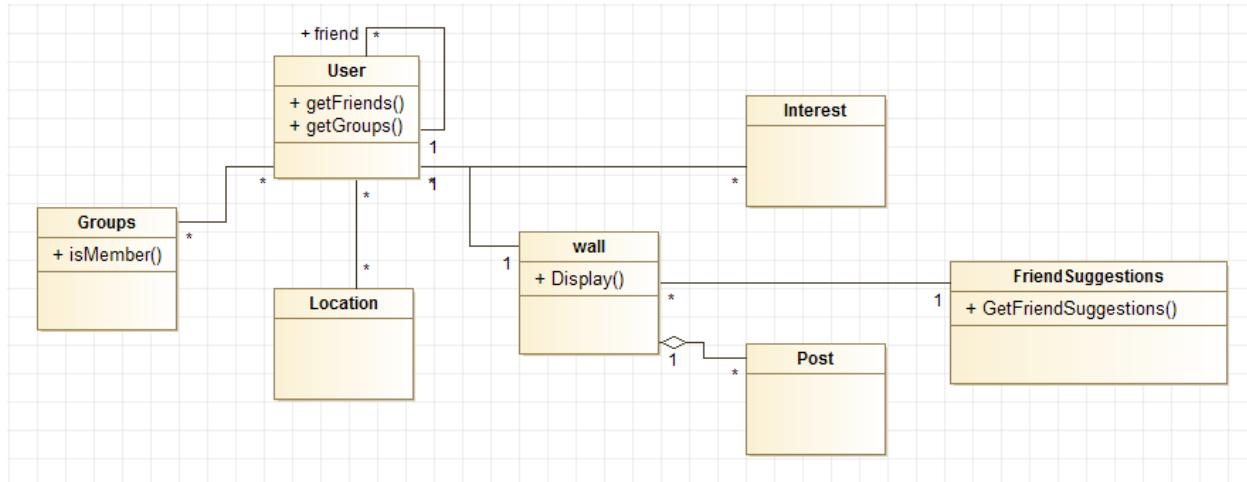
class HeMan : public Superhero {
public :
    virtual Weapon* createWeapon() {
        return new Sword();
    }
};
```

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Question 4

10 points

Consider following partial class diagram of an example "Facebook" system



There is a "Display Wall" use case which <<includes>> another use case "Get Friend Suggestions"

Prepare a sequence diagram for the use case "Get Friend Suggestions". You have to use only the provided functions. You are not allowed to create new functions in any class.

- `getFriends()`: returns a list of friends for a user
- `getGroups()`: returns a list of groups for a user
- `isMember()`: takes one parameters (user) and return True if the user is a member of the group otherwise returns False

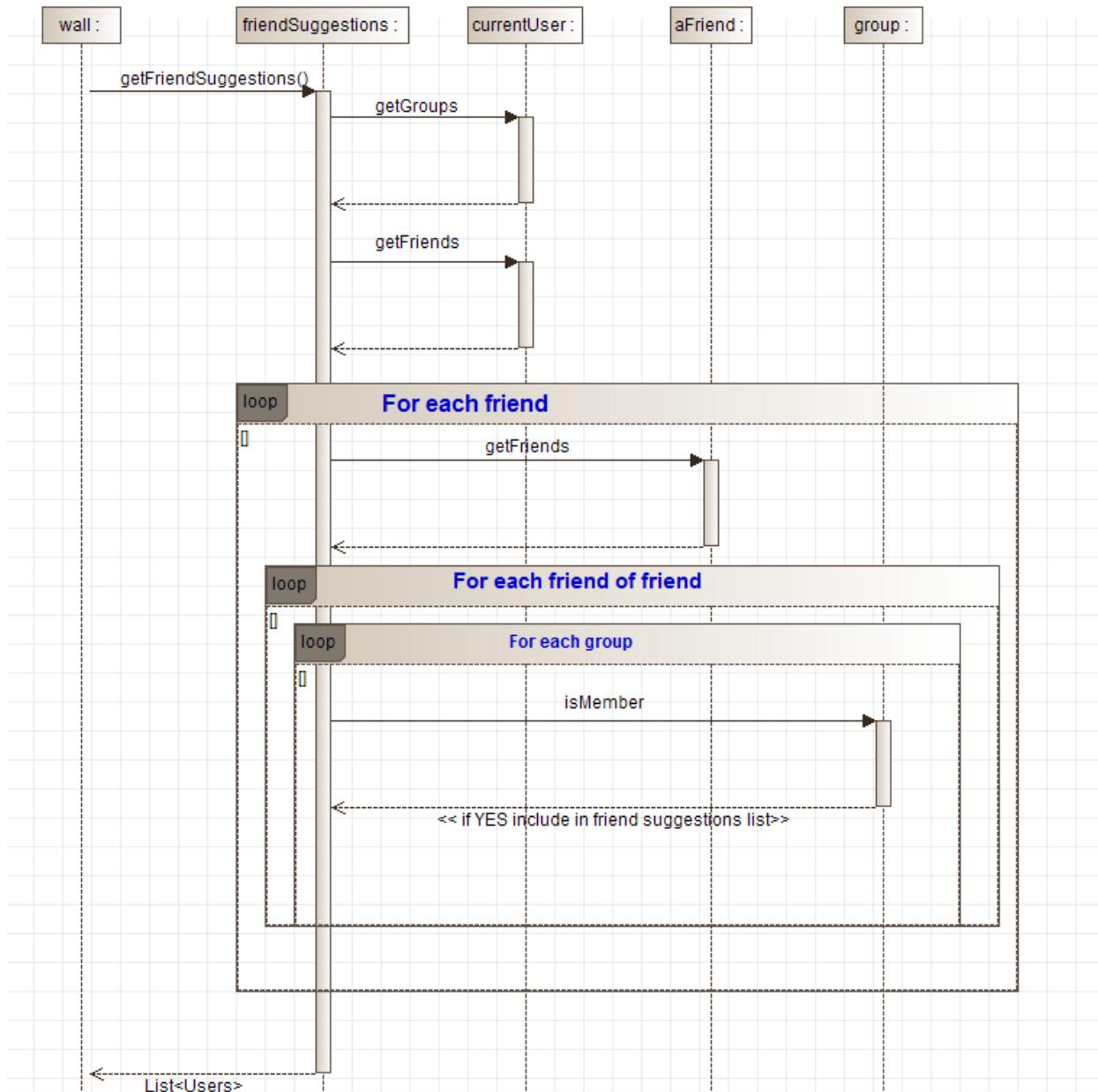
You have to provide complete flow for the public method `GetFriendSuggestions()`. This method accepts an object of the current user. It creates a list of friend suggestions based on the following rule:

- A person is suggested as a friend if he is a friend of an existing friend of the current user, and
- He shares a common group with the current user, i.e. both the user and the person are members of a single group

Remember that sequence diagram shows interaction between objects of classes. There can be multiple object of the same class in a sequence diagram if required. Show arguments and return types of each message passed between the objects in the sequence diagram.



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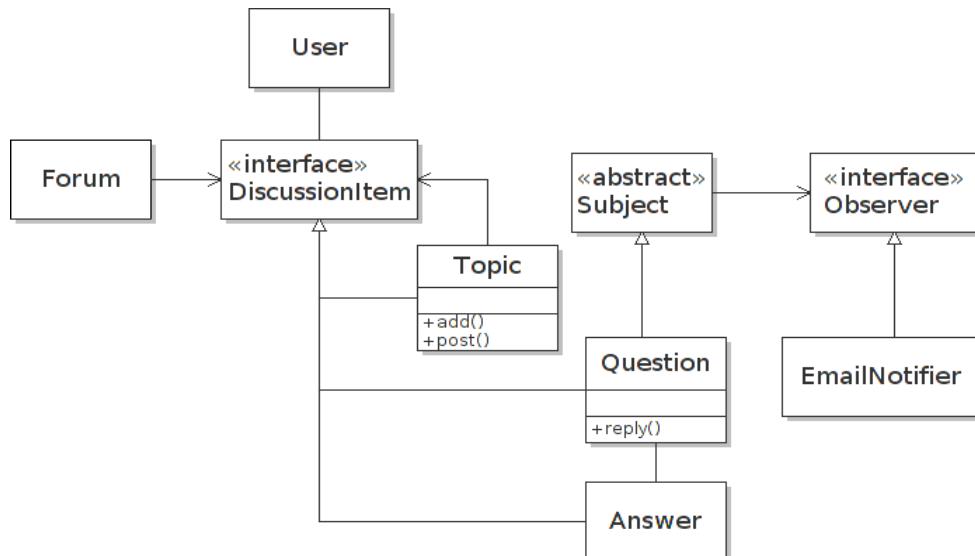
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Question 5

15 points

Consider a software for managing discussion forums. A forum is a collection of topics that may have sub-topics. For instance, an automobiles related forum (e.g. PakWheels) can have several topics e.g. Technical, Buy & Sell, Vintage (old) cars, etc. Each topic may have sub-topics, for instance, Technical discussion can relate to Electrical, Mechanical, Body work, etc. Such categorization may be done to any level of depth. A registered user can post a question on a topic. Others may post reply. When a reply is made, all the users participating in the discussion on that question are notified through email.

Develop a class diagram for the above software, making use of relevant design patterns. There is no need to show the attributes and methods, unless required to show the applicability of relevant design pattern.





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Question 1**15 points**

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- (b) In a good design, cohesion should be:
 - (i) Low (ii) High (iii) Medium (iv) Readable (v) Reusable

- (c) In object-oriented methodology, modular unit of implementation is:
 - (i) object (ii) method (iii) function (iv) class (v) package

National University of Computer and Emerging Sciences, Lahore Campus			
 <p>Course: Object-oriented Analysis & Design Program: BS (Computer Science) Duration: 180 Minutes Paper Date: 18-Dec-18 Section: All Exam: Final</p>	<p>Course Code: CS-309 Semester: Fall 2018 Total Marks: 60 Weight Page(s): 8 Reg. No.</p>		

- (d) Object can be defined as:
- (i) an entity with a name and state
 - (ii) an entity with a name and behavior
 - (iii) an entity with a state and behavior
 - (iv) an entity with a name, state and behavior
 - (v) an entity with identity, state and behavior
- (e) Polymorphism requires the following conditions for implementation:
- (i) overriding, subtyping and static binding
 - (ii) overriding, subtyping and dynamic binding
 - (iii) overloading, subtyping and static binding
 - (iv) overloading, subtyping and dynamic binding
 - (v) overriding, subtyping and method binding

Question 2

10 points

Softec is a prestigious event at FAST-NU. A number of different events are held under the Softec umbrella. These include Software Competition, Programming Competition, IdeasXtreme, etc. Numerous participants from various universities and institutes across the country participate and register for these events.

Softec society plans to develop an online registration system for all these events.

Participants can register for multiple events either individually or in teams according to event requirements.

Each event has an associated registration fee that is to be paid manually using a Bank Draft. Registration of participant(s) is confirmed only once the registration fee is received by Softec society.

Some events may have some special requirements for registration. For example, Software Competition requires from the participating team to submit an Abstract of their software at the time of registration. This Abstract needs to be evaluated and approved by a panel of evaluators before the registration is accepted.

Similarly, other events may have their own special requirements

Initially, participants submit their registration application. Once all the registration requirements for the concerning event are fulfilled and registration fee is received, the registration is confirmed.

Participants are notified of the confirmation through an email.

National University of Computer and Emerging Sciences, Lahore Campus

Course:	Object-oriented Analysis & Design	Course Code:	CS-309
Program:	BS (Computer Science)	Semester:	Fall 2018
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Develop a use-case diagram for Softec Registration System, illustrating the actors and their respective use-cases. Show important inclusions and extensions, if applicable.

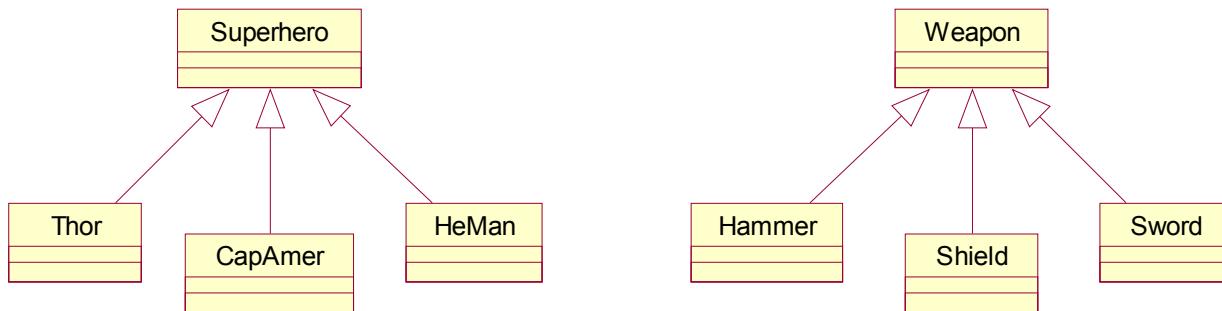


Course:	Object-oriented Analysis & Design	Course Code:	CS-309
Program:	BS (Computer Science)	Semester:	Fall 2018
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Exam:	Final	Reg. No.	

Question 3

10 points

Consider the following superheroes and their weapons:



The following code assigns a weapon to each superhero:

```

#include <typeinfo>

Weapon* createWeapon(Superhero* ptr) {
    string n = typeid(*ptr).name();
    if (n == "Thor")
        return new Hammer();
    else if (n == "CapAmer")
        return new Shield();
    else if (n == "HeMan")
        return new Sword();
}
  
```

Rewrite / Refactor the above program to improve the program design. If you add any new function(s) during the process then show their code as well.

National University of Computer and Emerging Sciences, Lahore Campus

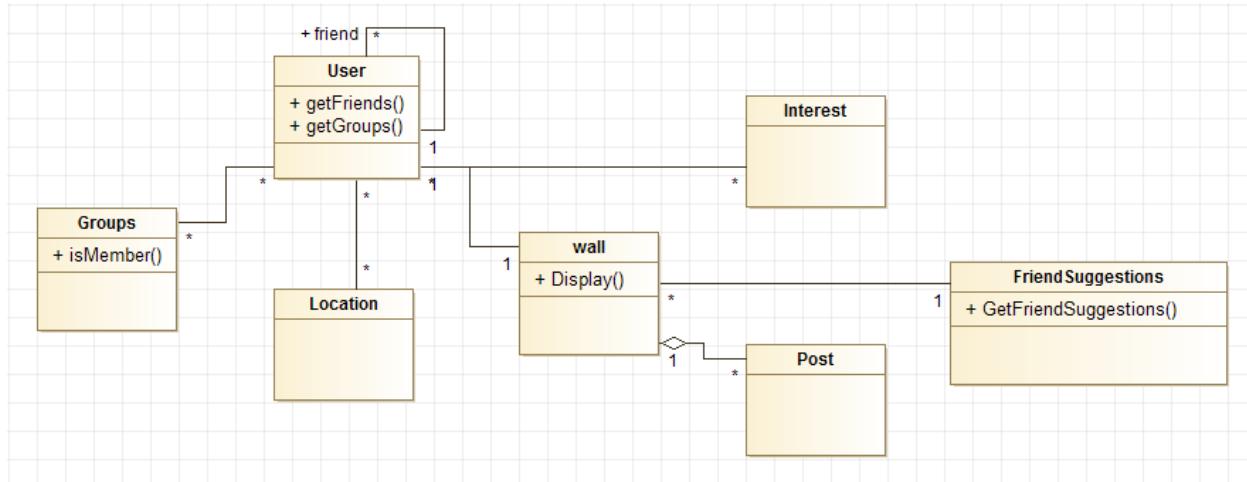
Course:	Object-oriented Analysis & Design	Course Code:	CS-309
Program:	BS (Computer Science)	Semester:	Fall 2018
Duration:	180 Minutes	Total Marks:	60
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National University of Computer and Emerging Sciences, Lahore Campus			
 Course: Object-oriented Analysis & Design Program: BS (Computer Science) Duration: 180 Minutes Paper Date: 18-Dec-18 Section: All Exam: Final	Course Code: CS-309 Semester: Fall 2018 Total Marks: 60 Weight: 8 Page(s): 8 Reg. No.		

Question 4

10 points

Consider following partial class diagram of an example "Facebook" system



There is a "Display Wall" use case which <<includes>> another use case "Get Friend Suggestions"

Prepare a sequence diagram for the use case "Get Friend Suggestions". You have to use only the provided functions. You are not allowed to create new functions in any class.

- `getFriends()`: returns a list of friends for a user
- `getGroups()`: returns a list of groups for a user
- `isMember()`: takes one parameters (user) and return True if the user is a member of the group otherwise returns False

You have to provide complete flow for the public method `GetFriendSuggestions()`. This method accepts an object of the current user. It creates a list of friend suggestions based on the following rule:

- A person is suggested as a friend if he is a friend of an existing friend of the current user, and
- He shares a common group with the current user, i.e. both the user and the person are members of a single group

Remember that sequence diagram shows interaction between objects of classes. There can be multiple object of the same class in a sequence diagram if required. Show arguments and return types of each message passed between the objects in the sequence diagram.

National University of Computer and Emerging Sciences, Lahore Campus

Course:	Object-oriented Analysis & Design	Course Code:	CS-309
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Course:	Object-oriented Analysis & Design	Course Code:	CS-309
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Question 5**15 points**

Consider a software for managing discussion forums. A forum is a collection of topics that may have sub-topics. For instance, an automobiles related forum (e.g. PakWheels) can have several topics e.g. Technical, Buy & Sell, Vintage (old) cars, etc. Each topic may have sub-topics, for instance, Technical discussion can relate to Electrical, Mechanical, Body work, etc. Such categorization may be done to any level of depth. A registered user can post a question on a topic. Others may post reply. When a reply is made, all the users participating in the discussion on that question are notified through email.

Develop a class diagram for the above software, making use of relevant design patterns. There is no need to show the attributes and methods, unless required to show the applicability of relevant design pattern.

**Software Design and
Architecture (SE2002)**

Date: May 29th 2024

Course Instructor(s)

Dr. Ali Afzal Malik (BSE-4A, BSE-4B)

Mr. Muhammad Amir Iqbal (BSE-4C, BSE-4D)

Final Exam

Sections: ALL

Total Time: 3 Hours

Total Marks: 70

Weight: 40%

Total Questions: 07

59

Student Name

(Hasan Yahya)

Roll No

(22L-7971(BSE-4D))

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.

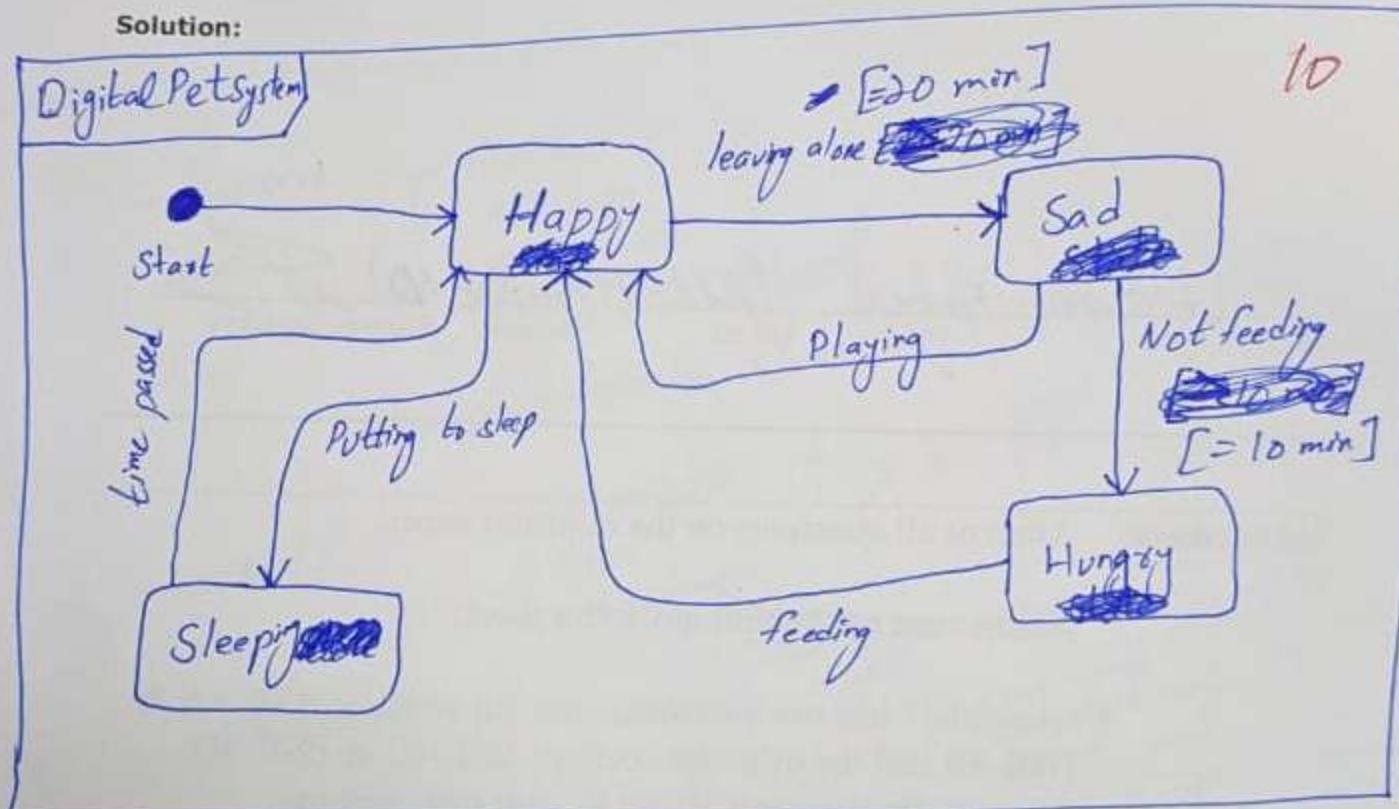
CLO 4: Use different UML notations for software design

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 mentions end of state, represented by

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

Q2

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.

*Assuming
only part
of Adapter
class is required.*

```
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
    }
}
```

Using this code as base

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

Solution:

public class ModernGraphicsLibrary
void drawLine(int x1, int y1, int x2, int y2)
// Efficient code to draw line

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

Page 3 of 9

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public Adapter () {
this.mgl = new ModernGraphicsLibrary();

~~No override this code~~

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

*Sorry about the
writing & bad handwriting*

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

Q3

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.

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

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.

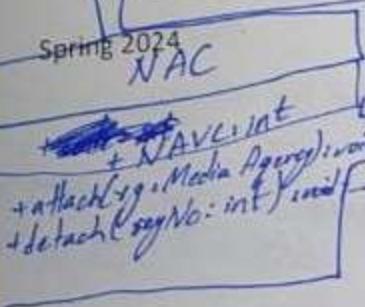
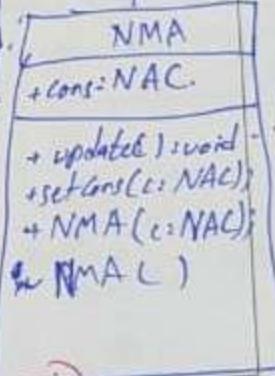
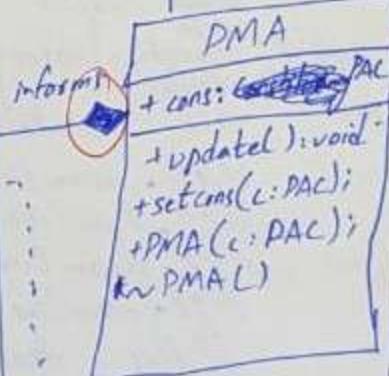
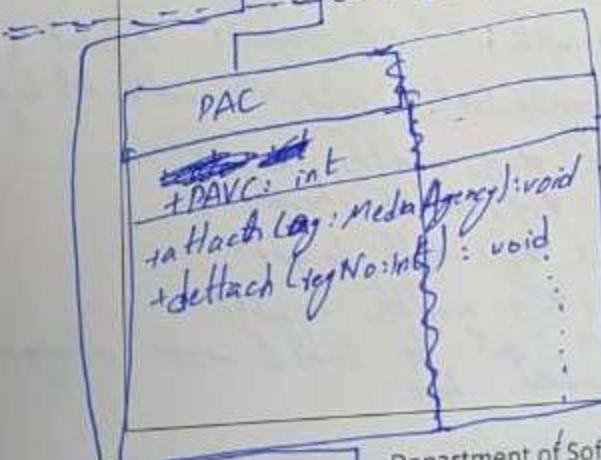
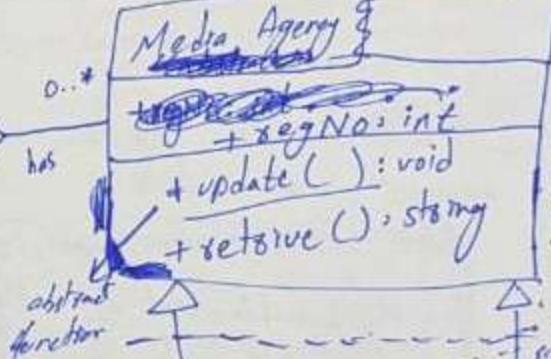
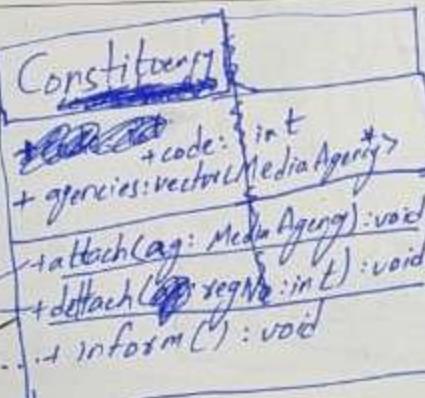
8

Most appropriate design pattern:

Observer Pattern.

*cout << "PAVC has
changed to " << PAVC;
PAC·PAVC;*

*are abstract
classes*



Department of Software Engineering

informs

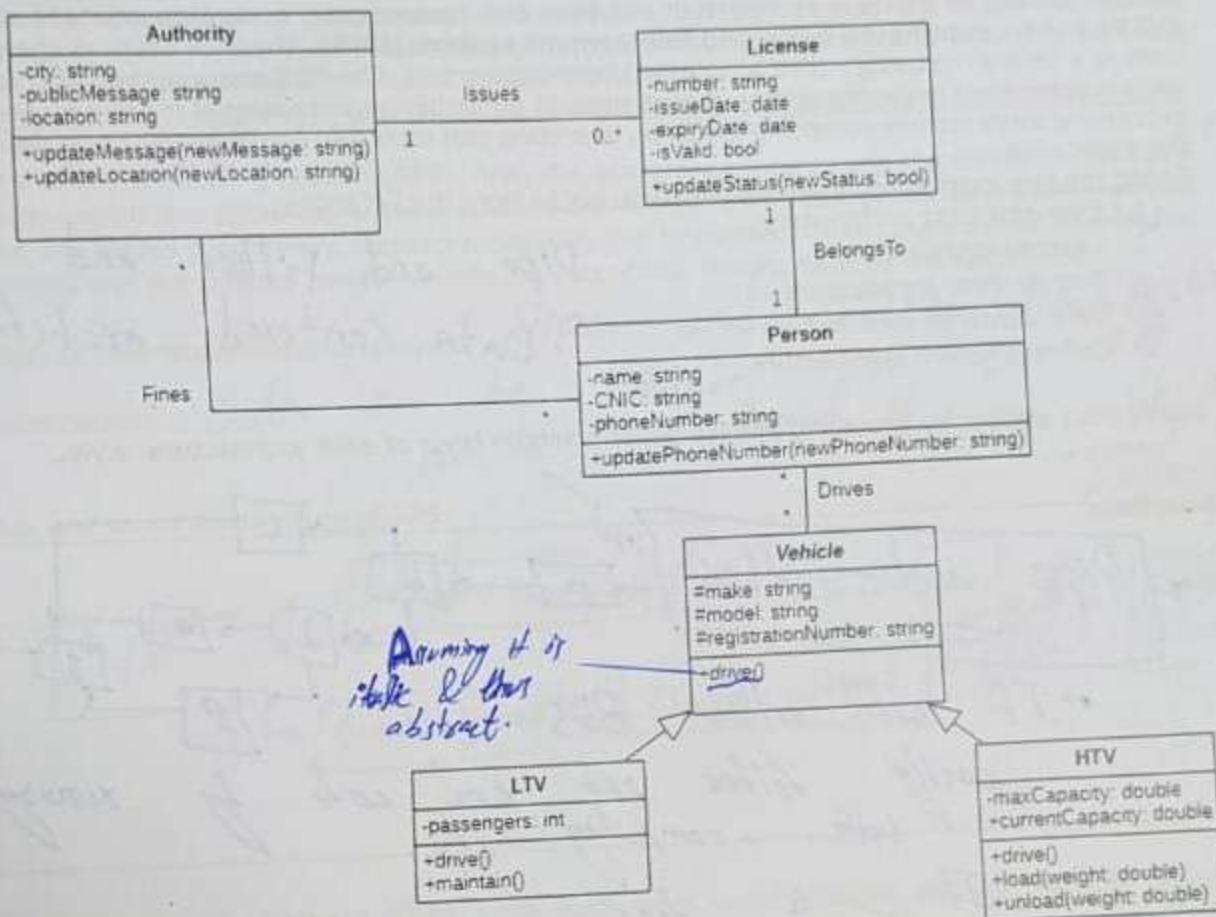
Page 4 agencies.pushback(ag);

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

*This will
pop at
index
where
regNo == rgNo.*

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.

8

S#	Class	Metric (Abbreviation)	Value
1	License	Class Size (CSize)	5 (4 attributes + 1 method)
2	LTV	Class Size (CSize)	3 (4 attributes + 1 method)
3	HTV	Class Size (CSize)	5 (2 + 3) + 2 methods
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

Ruf work

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$$SI(LTV) = \frac{1 \times 0.1}{2} = \frac{1}{2} = 0.5$$

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

$SI = \frac{NO \times Depth}{NO}$
Page 5 of 9

$NO =$ No of overidden operations
 $NO =$ No of Operators (Total).

10

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.

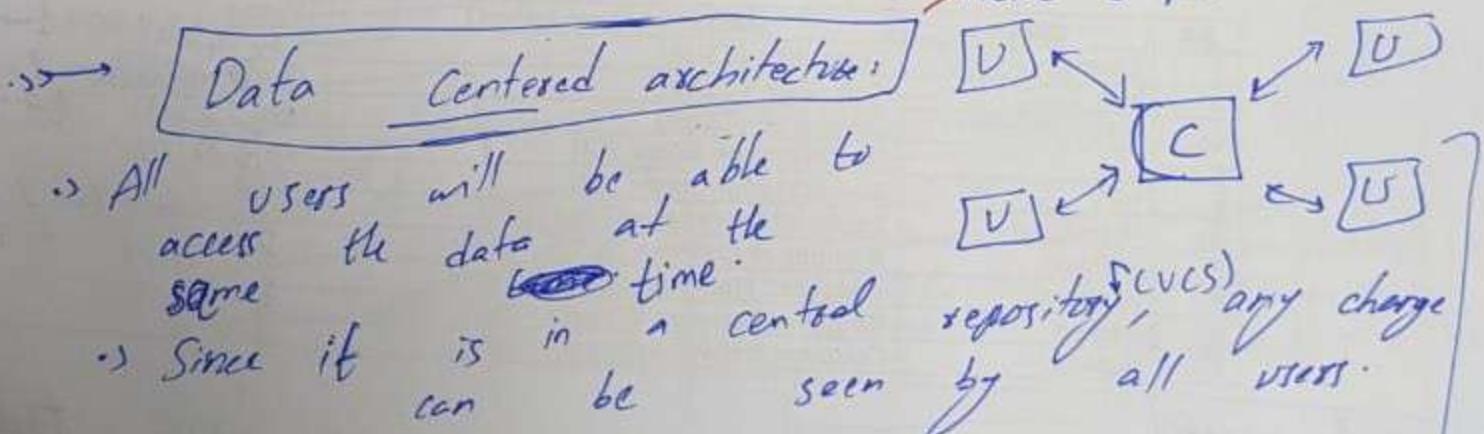
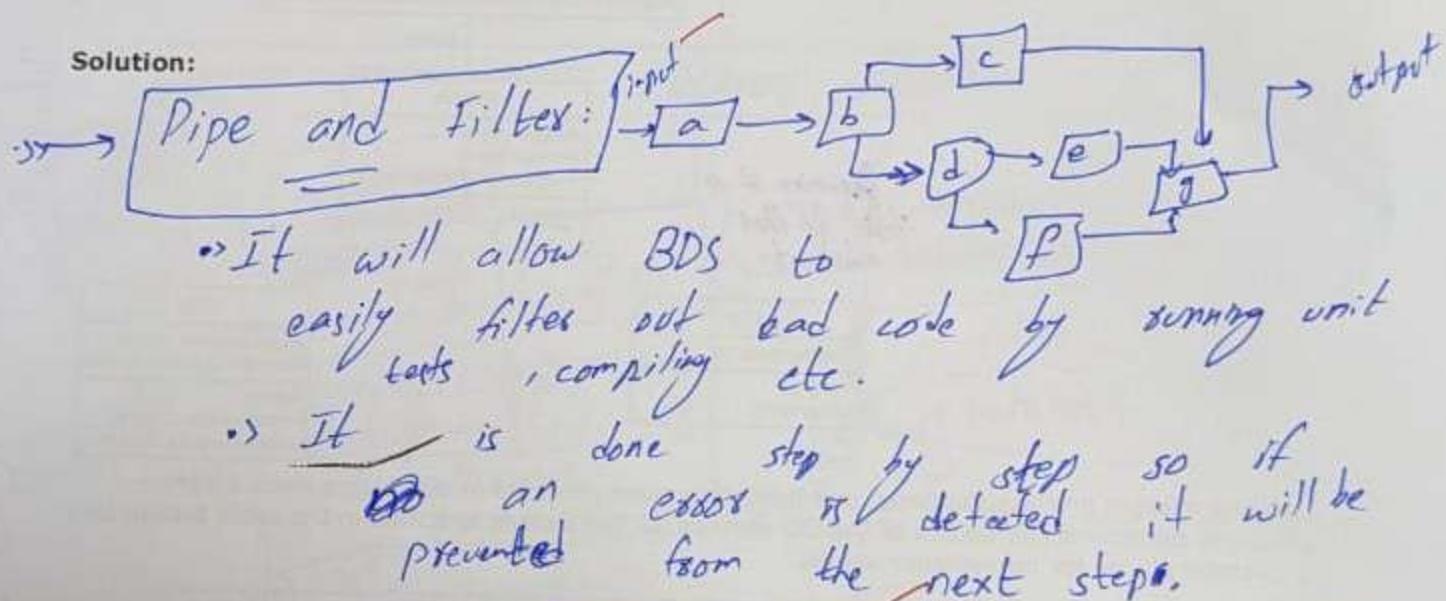
Select the two most appropriate architectural styles from the list below:

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:



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

Page 6 of 9

Co control
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.

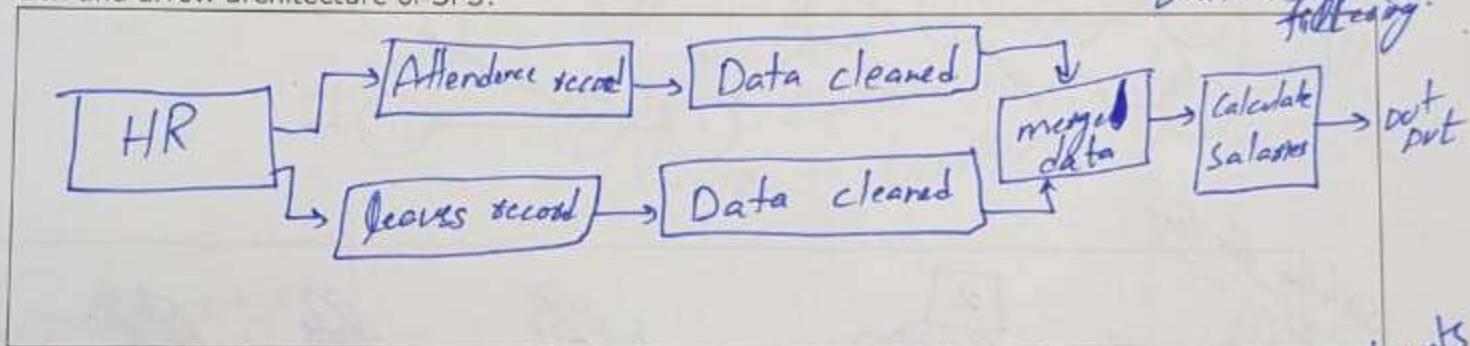
Note: No credit will be given in case of failure to identify the most appropriate architectural style.

- 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:

Justification: Data can be taken in parallel, steps can be performed & can be finally merged. Also, it allows for filtering.
eg: image processing.

Box and arrow architecture of SPS:

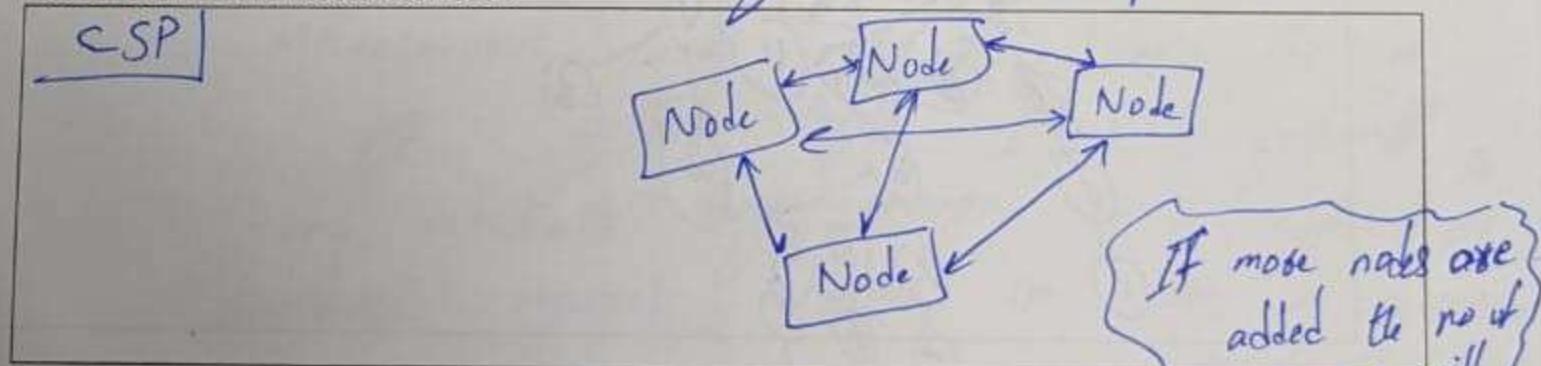


- b. In a code sharing platform (CSP), each node owns some (but not all) part of code. Nodes request each other to access the parts of code they need but do not own.

Most appropriate architectural style:

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

Box and arrow architecture of CSP:



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

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

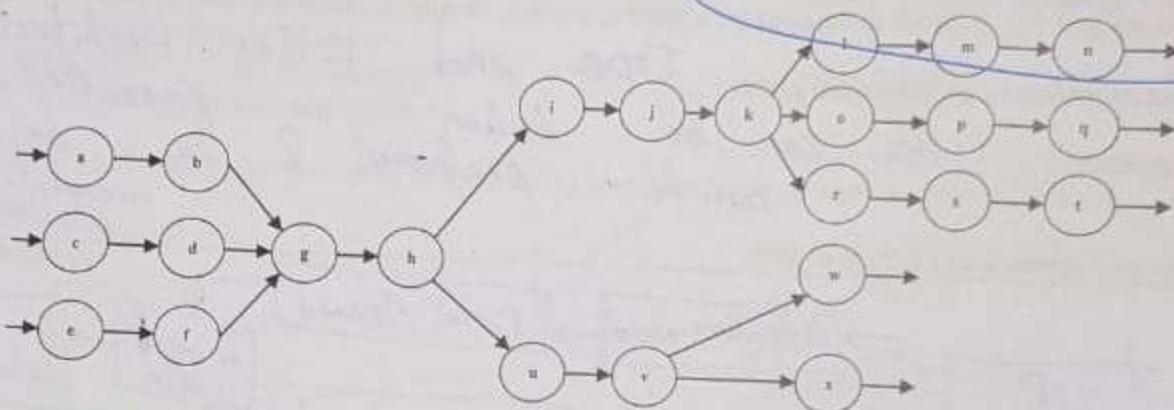
Q7 [For Sections (BSE-4A, BSE-4B)] [10]

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.

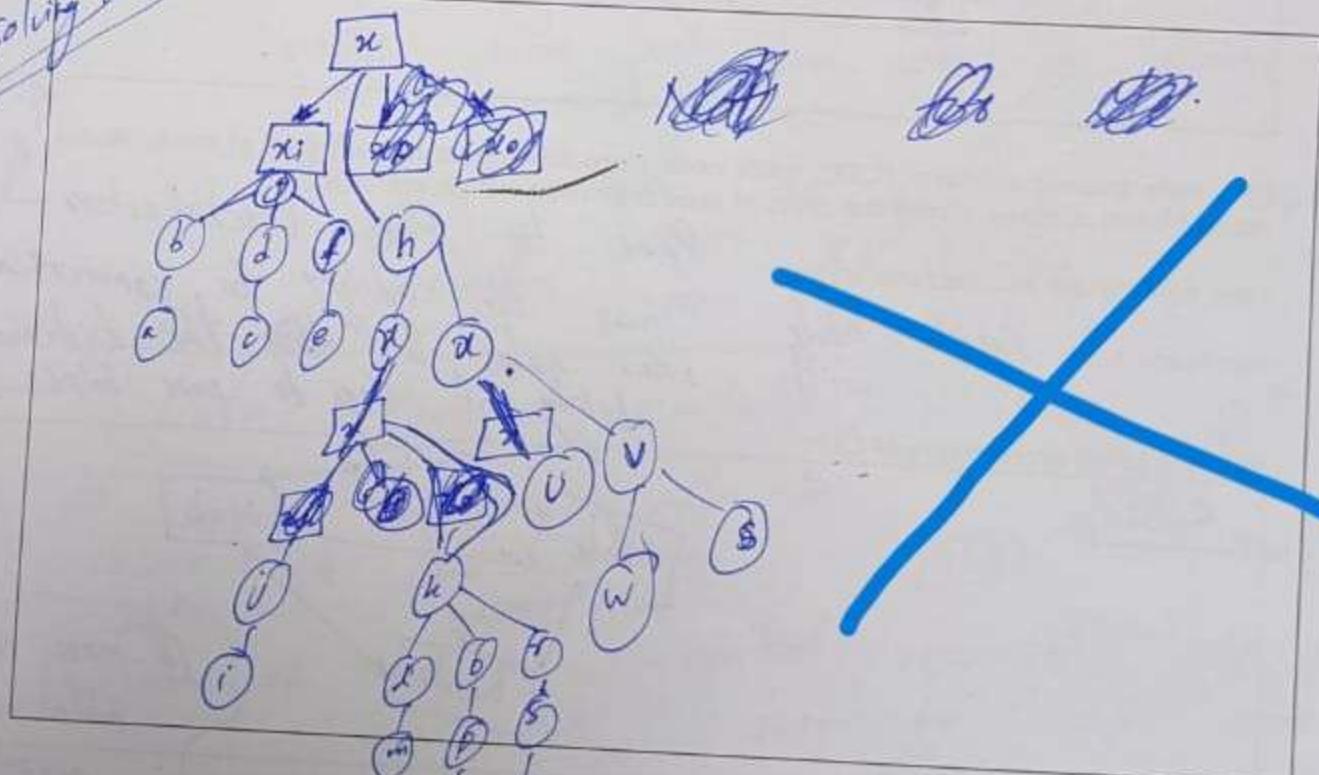
The following information should be used for mapping:

- 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.
- » It can easily allow for parallel concurrent requests.
- » It can easily scale up to handle more traffic.

Disadvantages:

- » If any change is made in the microservice ~~system~~ 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 database requires changes in the micro-service endpoints (such as API's), so that they can easily communicate with central system.



Course:	Software Design & Analysis	Course Code:	CS3004
Program:	BS (CS)	Semester:	Fall 2023
Duration:	180 Minutes (3 Hours)	Total Marks:	100
Paper Date:	29-Dec-23	Weight:	40%
Section:	All	Page(s):	10
Exam:	Final		

Instruction/Notes:

Attempt all questions on the question paper. Neither use nor submit any extra sheet.

Name _____

Question 1 (Max. Marks = 1 x 20 = 20) [CLO 1]

Circle the correct choice in each of the following MCQs. Only one option should be circled. Think before choosing the correct choice. Cutting will result in disqualification of answer.

1. _____ is the sharing of attributes and operations among classes based on a hierarchical relationship.
 - a. Association
 - b. Composition
 - c. Reflexive association
 - d. Inheritance
 - e. Abstraction

2. _____ lets you focus on essential aspects of an application while ignoring the details.
 - a. Abstraction
 - b. Encapsulation
 - c. Classification
 - d. Relationship
 - e. Inheritance

3. All of the following are correct except
 - a. Aggregation is a strong kind of association
 - b. Composition is a strong kind of aggregation
 - c. Composition is a strong kind of association
 - d. Aggregation is a strong kind of composition

4. "A dining philosopher uses a fork" should be represented by a/n _____
 - a. Association
 - b. Aggregation
 - c. Composition
 - d. Inheritance
 - e. Polymorphism

5. "University consists of many departments." should be represented by a/n _____
 - a. Association
 - b. Aggregation
 - c. Composition
 - d. Inheritance
 - e. Polymorphism

6. Sequence diagrams show the
- a. static picture of the system
 - b. dynamic picture of the system**
 - x c. events and transitions
 - x d. classes and their attributes
7. In a UML state diagram, can a do-activity be interrupted by an event that is received during its execution?
- a. Yes**
 - b. No
8. In a UML use case diagram, use case extension indicates _____
- a. An optional scenario**
 - b. A generalization-specialization relationship between use cases
 - c. A deviation from the UML standard
 - d. All of the above

9. What is coupling between two classes?

- a.** The degree to which these two classes are connected to each other
- b. The degree to which these two classes are independent of each other
- c. The degree to which these two classes share a common interface
- d. None of the above

10. Which design pattern is used to create objects without specifying the exact class to create

- a. State
- b. Template
- c. Factory Method**
- d. Composite

11. Which design pattern defines a one-to-many dependency among objects?

- a. Singleton
- b. Template Method
- c. Observer**
- d. Factory Method

12. Which phase of the SDLC focuses on "understanding the problem"?

- a. Analysis**
- b. Design
- c. Planning
- d. Maintenance

13. Which design pattern ensures that a class has only one instance and provides a global point of access to it?

- a. Singleton**
- b. Composite
- c. Observer
- d. Factory Method

14. Which design pattern defines the skeleton of an algorithm in an operation, deferring some steps to subclasses?

- a. State
- b. Template Method**
- c. Factory Method
- d. Composite

15. When a class replaces the implementation of a method that it has inherited it is called _____

- a. Overloading
- b. Overriding
- c. Overwriting
- d. None

16. When a (derived) class inherits features (data and operations) from another derived class, it is called as _____

- a. Complex Inheritance
- b. Multilevel inheritance
- c. Multiple inheritance
- d. None

17. According to the _____, there should be only one reason to change a class.

- a. ISP
- b. SRP
- c. OCP
- d. All of the above

18. Which phase of the SDLC has a major focus on "how the system will work"?

- a. Analysis
- b. Design
- c. Planning
- d. Maintenance

19. A high value of the coupling between objects (CBO) metric represents a good design.

- a. True
- b. False

20. A good design helps in

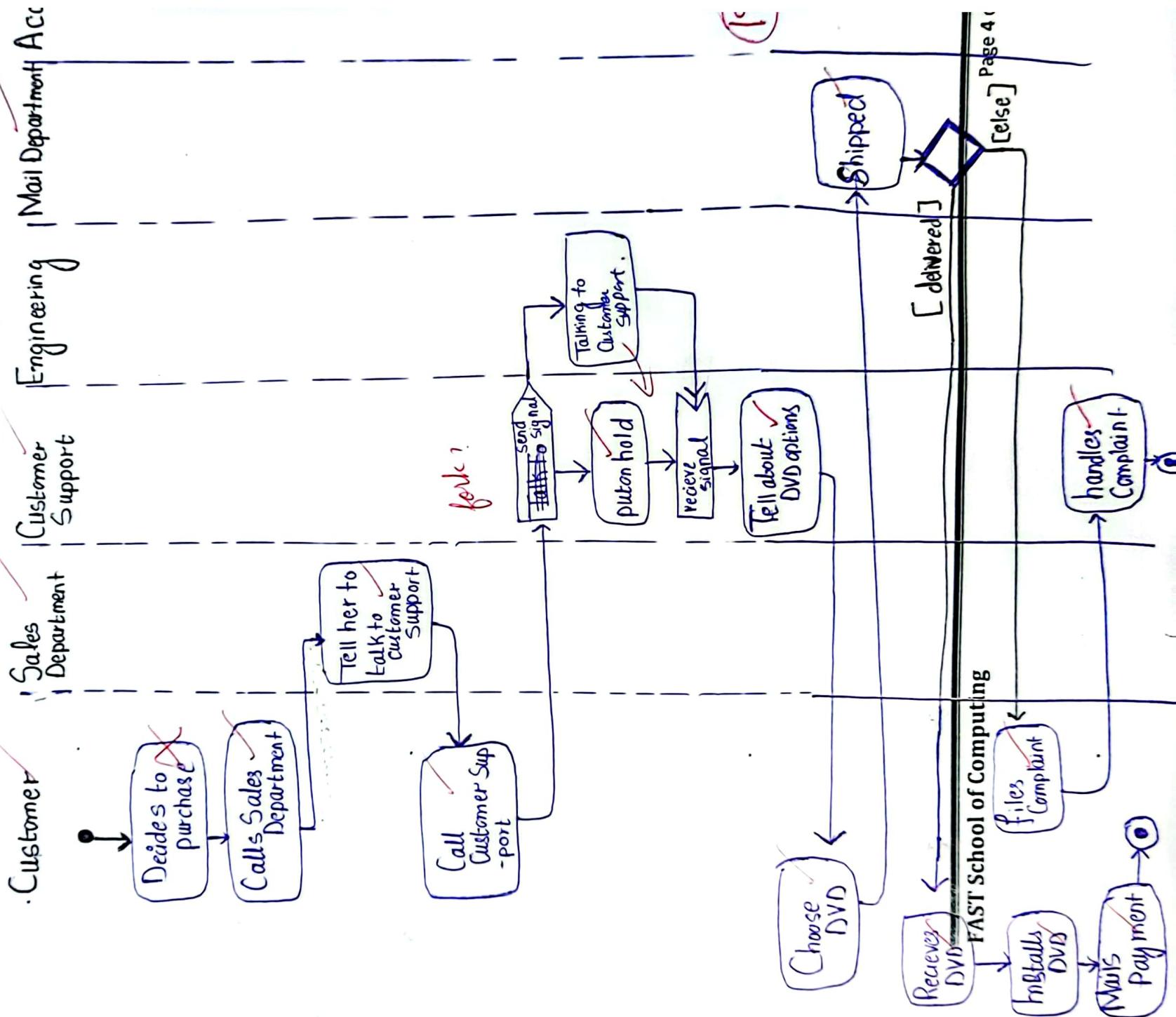
- a. Programming
- b. Testing
- c. Maintenance
- d. All of the above
- e. None of the above

(20)

Question 2 (Max. Marks = 20) [CLO 4]

A customer decides to upgrade her PC and purchase a DVD player. She begins by calling the sales department of the PC vendor and they tell her to talk to customer support. She then calls customer support and they put her on hold while talking to engineering. Finally, customer support tells customer about several supported DVD options. The customer chooses a DVD and it is shipped to the mail department. If the order is delivered, the customer receives the DVD, installs it, and mails her payment to accounting. Otherwise, the customer files a complaint that the order was delivered and customer support handles the complaint.

Construct a UML swimlane activity diagram to show the various interactions in the above process.



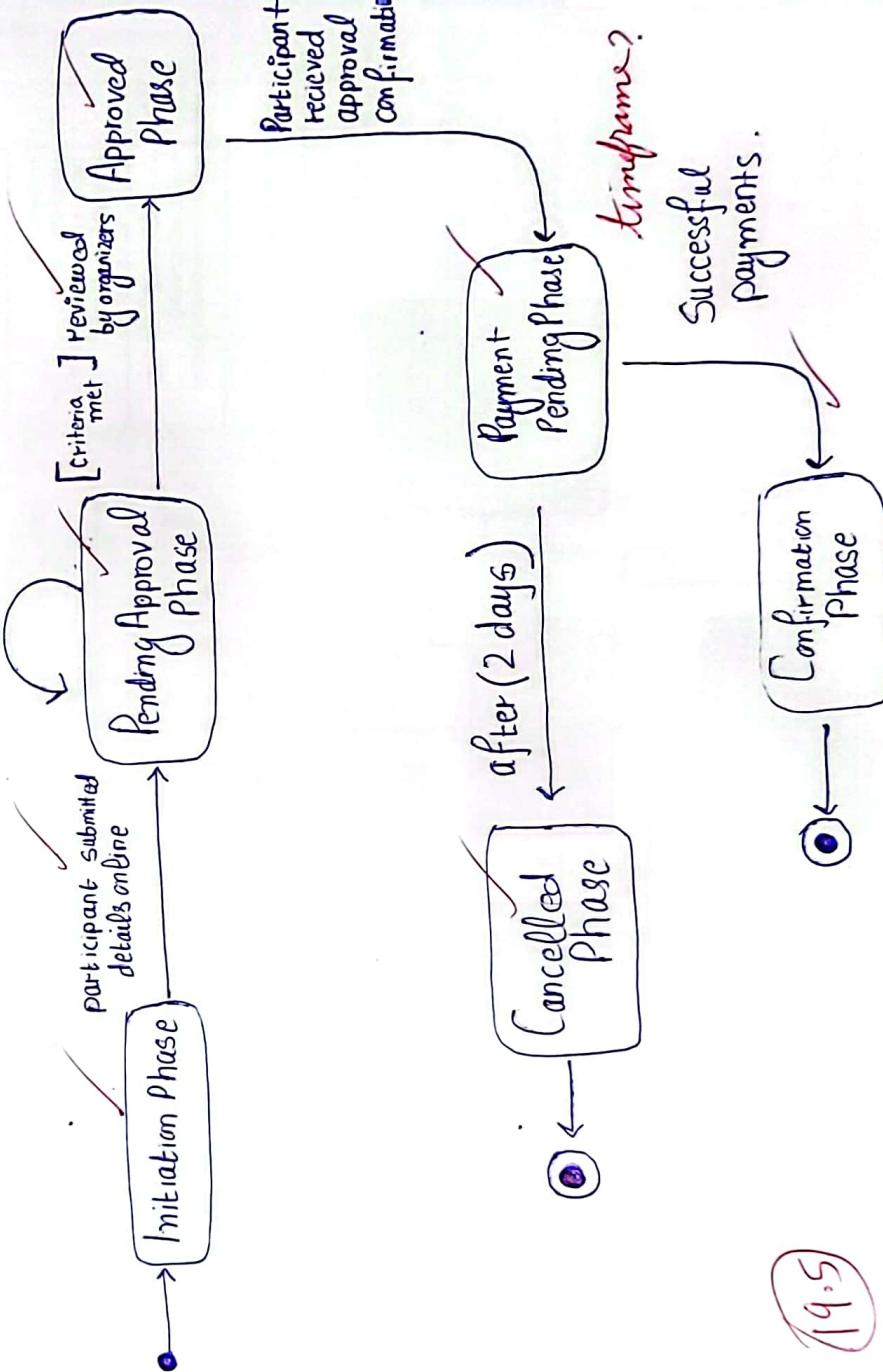
Question 3 (Max. Marks = 20) [CLO 3]

The Sports Event Registration System (SERS) is designed to revolutionize the process of participant registration for sports events, eliminating complexities and ensuring a seamless experience for both organizers and participants. The state diagram for a participant's registration provides a comprehensive visual representation of the registration phases from initiation to event confirmation.

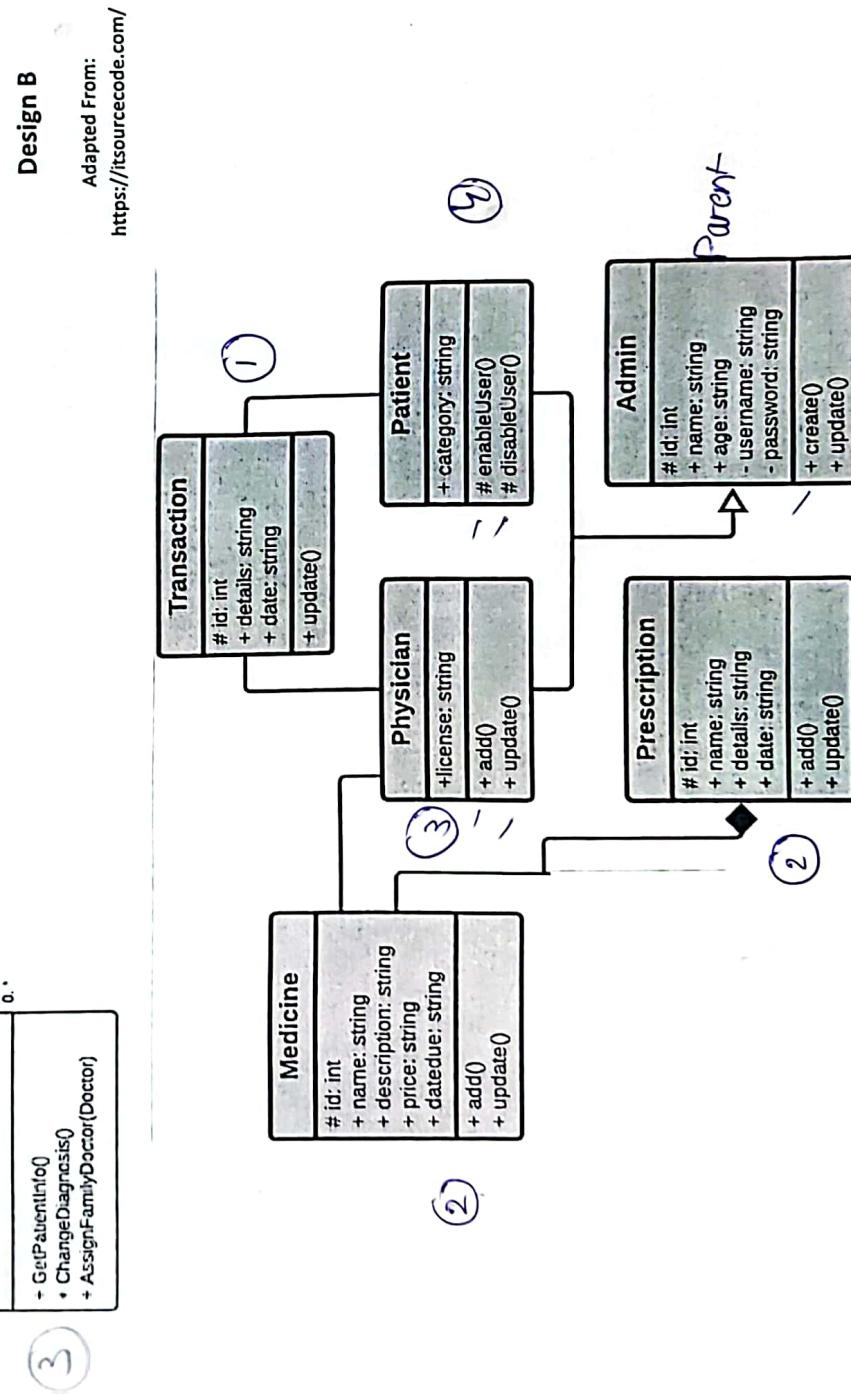
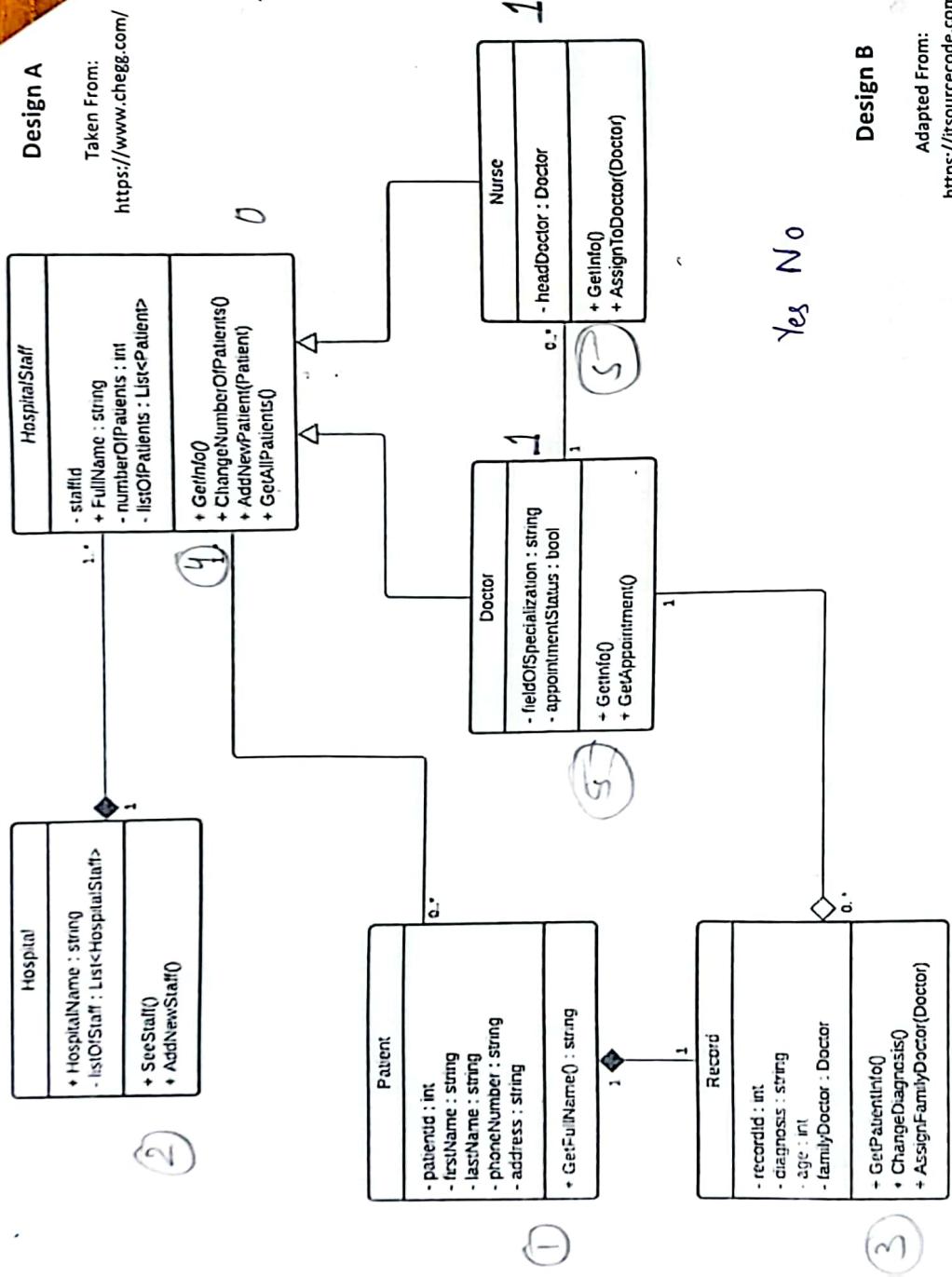
The first phase of registration is the initiation phase. Once a participant has submitted his/her details through an online form, registration enters the Pending Approval Phase allowing organizers to review the submitted information. If the criteria are met, registration moves to the Approved Phase. Otherwise, it remains in the Pending Approval Phase. In the Approved Phase, after the participant has received approval confirmation, registration proceeds to the Payment Pending Phase. Here, the participant is given a specified timeframe of 2 days to make the payment. If payment is not made within this period, registration transitions to the Canceled Phase and the process ends. Successful payment made within the specified timeframe transitions registration to the Confirmation Phase indicating that the participant is officially registered and the process is complete.

Without making any assumptions, model the above information using a UML 2 state diagram.

Criteria [organizers' details] reviewed



Question 4 (Max. Marks = 2 x 10 = 20) [CLO 5]



(19)

diagrams above show 2 alternative designs (A and B) of a hospital management system. Calculate the values of the metrics given in the table below (round up to 2 decimal places) for both designs. Show working.

S#	Metric	Design A	Design B
1	Maximum Depth of Inheritance Tree	Parent : HospitalStaff Depth = 0 Child : Doctor, Nurse Depth = 1 Maximum Depth = <u>1</u>	Parent: Admin Depth = 0 Child : physician, patient Depth = 1 Maximum = <u>1</u> , Depth
2	Minimum Possible Lack of Cohesion of Methods	0.	0.
3	Average Weighted Methods per Class	Class # of methods Total classes = 6 Hospital 2 . <u>2+1+3+4+5+5</u> Patient 1 . 6. Record 3. HospitalStaff 4. <u>3.33</u> Doctor 5. Nurse 6.	Class # of methods Medicine 2 Transaction 1 Physician 3 Patient 4 Admin 2 Prescription 2
4	Average Number of Children	Parent Class: <u>HospitalStaff</u> 2 Children: <u>Doctor, Nurse</u> Other 5 classes have zero children $0+0+0+0+2 = 0.333$	Parent: Admin Children: Physician (2) total Classes 6 other 5 classes have 0 children $0+0+0+0+2 = 0.333$
5	Average Coupling Between Objects	Class CBO Hospital 1 Patient 2 Record 2 HospitalStaff 4 Doctor 3 Nurse 2	Class CBO Total Classes = 6 Medicine 2 Transaction 2 Physician 3 Patient 2. Admin 2. Prescription 1 $\frac{14}{6} + 2.33 = \frac{12}{6} = 2$

Question 5 (Max. Marks = 20 = 10 + 5 + 5) [CLO 2]

- a. Improve the following code using an appropriate **design pattern**.

```
// Heros: captain america, he-man and thor
Weapon* createWeapon(Hero* her) {
    switch(her->who()) {
        case CAP: return new Shield();
        case HE: return new Sword();
        case Thor: return new Hammer();
    }
}
```

// Child classes of Weapon Class.

Design Pattern Used: Factory Method

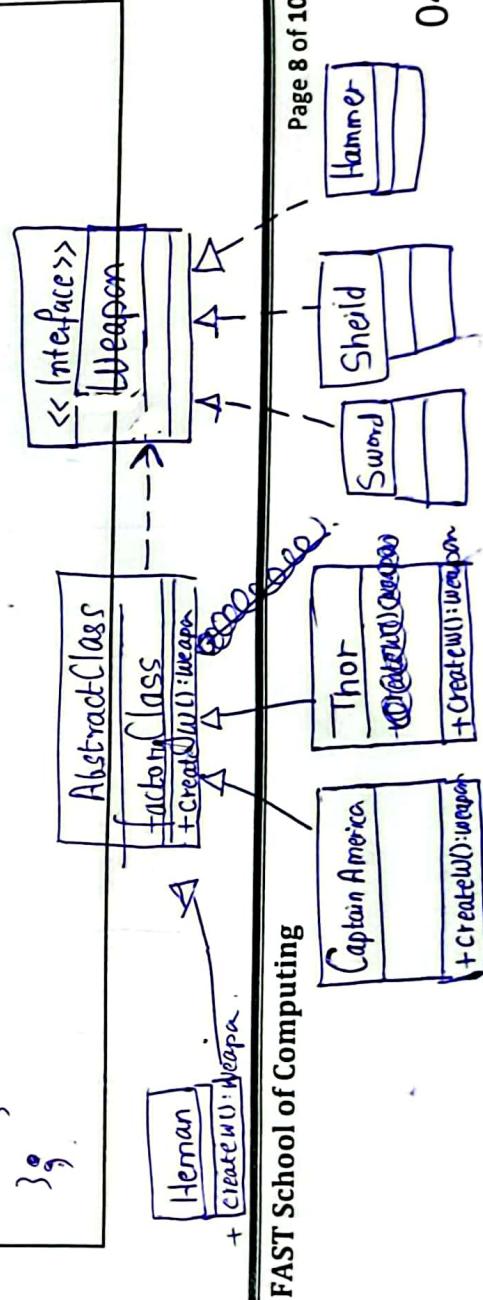
```
Class factoryClass {
    virtual Weapon* CreateWeapon() = 0;
};

Class Captain America : public factoryClass {
public:
    Weapon* CreateWeapon() override {
        return new Shield();
    }
};

Class HeMan : public factoryClass {
public:
    Weapon* CreateWeapon() override {
        return new Sword();
    }
};

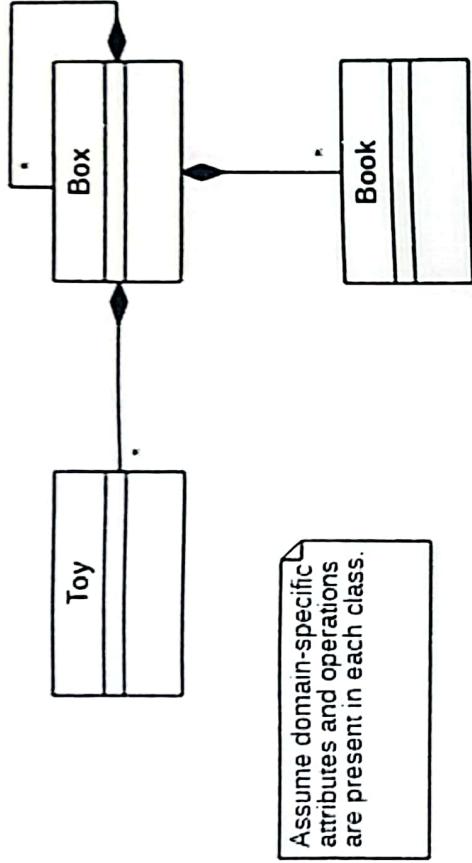
Class Thor : public factoryClass {
public:
    Weapon* CreateWeapon() override {
        return new Hammer();
    }
};
```

①

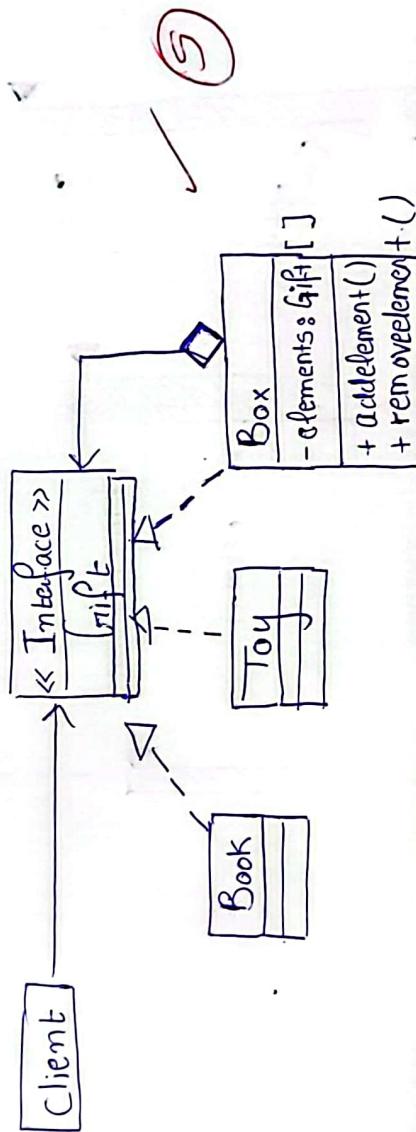


improve the following design using an appropriate **design pattern**:

Note: All three classes represent gifts sold by a gift shop.

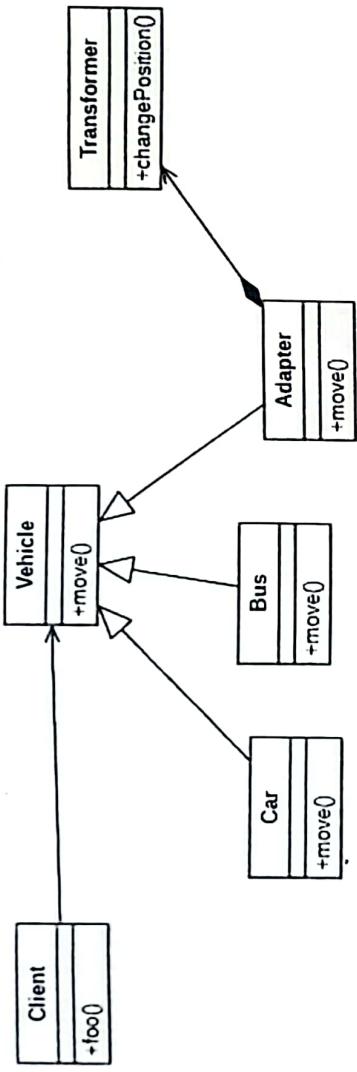


Design Pattern Used: Composite Design Pattern

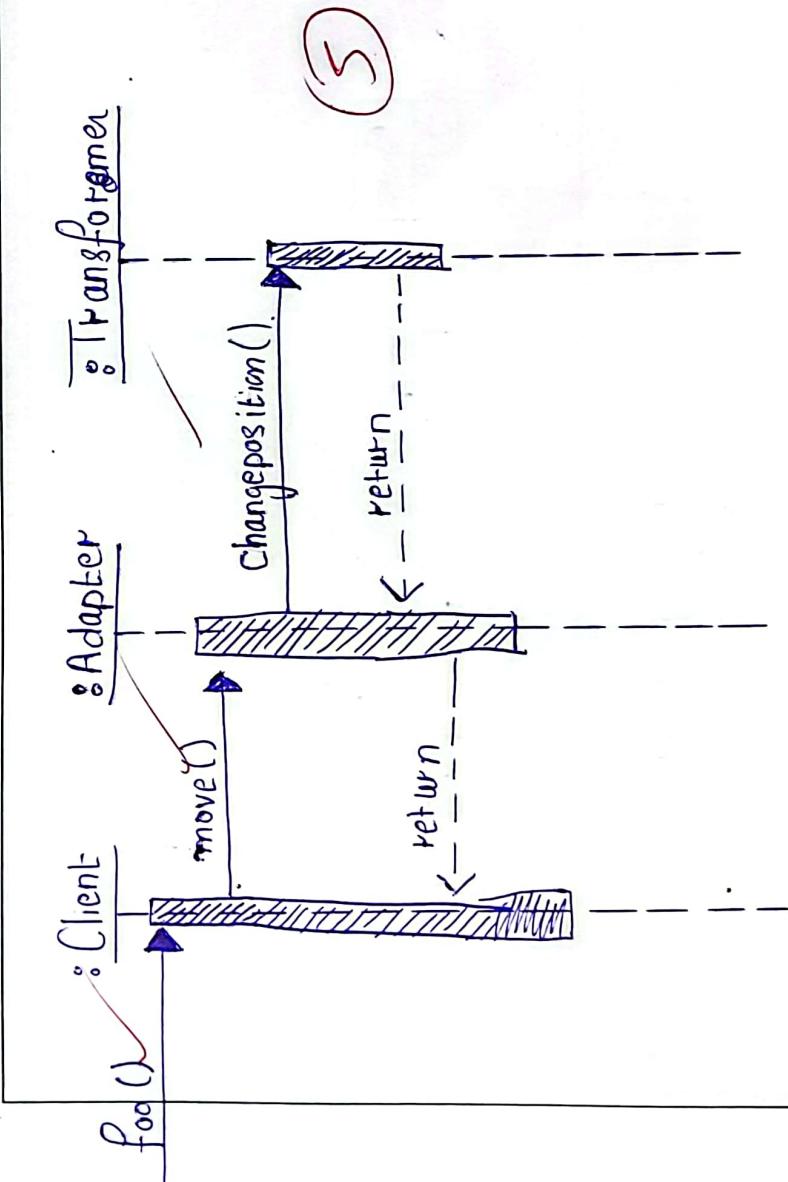


- Array of interface type objects in CompositeClass

- c. Consider the following (design) class diagram.



Give a (design) sequence diagram showing the following scenario:
The foo() function of a Client object calls the move() function of an Adapter object which in turn calls changePosition() function of a Transformer object.



National University of Computer and Emerging Sciences, Lahore Campus



Course:	Software Design &Analysis	Course Code:	CS3004
Program:	BS (CS)	Semester:	Fall 2022
Duration:	180 Minutes (3 Hours)	Total Marks:	50
Paper Date:	19-Dec-22	Weight	40%
Section:	All	Page(s):	6
Exam:	Final		

Instruction/Notes:

Attempt all questions on the question paper. Neither use nor submit any extra sheet.

Name: _____

Roll Number: _____

Section _____

Question 1(Max. Marks =10) [CLO 3]

A curator manages a single museum. Every museum has an address, contact number, and opening date. There are only two types of museums i.e. art museums and science museums. Art museums house one or more art galleries whereas science museums house one or more science exhibits. Art galleries display multiple works of art. An art work can be either a painting or a sculpture. All art works have a unique identification number (UIN), artist name, price, and creation date. Paintings have a medium (i.e. oil, watercolor, pastel) and type (i.e. abstract, landscape, still life, contemporary) whereas sculptures have form (i.e. free standing, relief), method (i.e. carving, casting, modeling, assembling), and material (e.g. metal, wood, plastic, mud, cloth, etc.). Science exhibits display multiple science projects. A science project can be either a mechanical project or an electromechanical project. All science projects are developed by teams of 3 to 5 scientists. A scientist can belong to one or more teams. Each scientist has a name, date of birth, and Pakistan Engineering Council (PEC) registration number and each team has a name and license number. All science projects have a title and description. Mechanical projects have horsepower while electromechanical projects have voltage and frequency. In order to visit a museum, a visitor must purchase a ticket sold by that museum. Each visitor has a name, type (i.e. adult, child, student, senior citizen), and CNIC number while each ticket has a serial number, price, and expiry date. Students and senior citizens get 50% discount on the price of the ticket while children get 75% discount.

Model the information given above using a **design class diagram**. Your class diagram should not contain the operations (i.e. third) compartment of classes.

Use the **next page** for answering this question.

Name: _____

Roll Number: _____

Section _____

[Use this page for answering Question 1 only.]

Name: _____

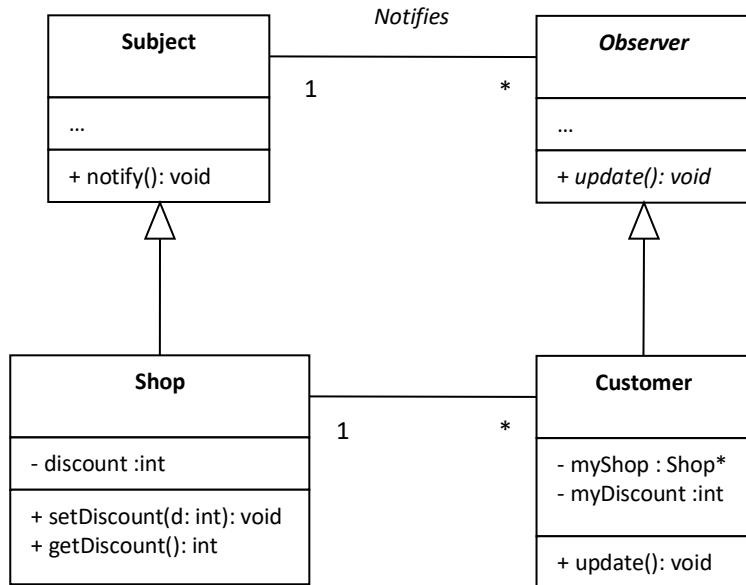
Roll Number: _____

Section _____

Question 2(Max. Marks = 10) [CLO 3]

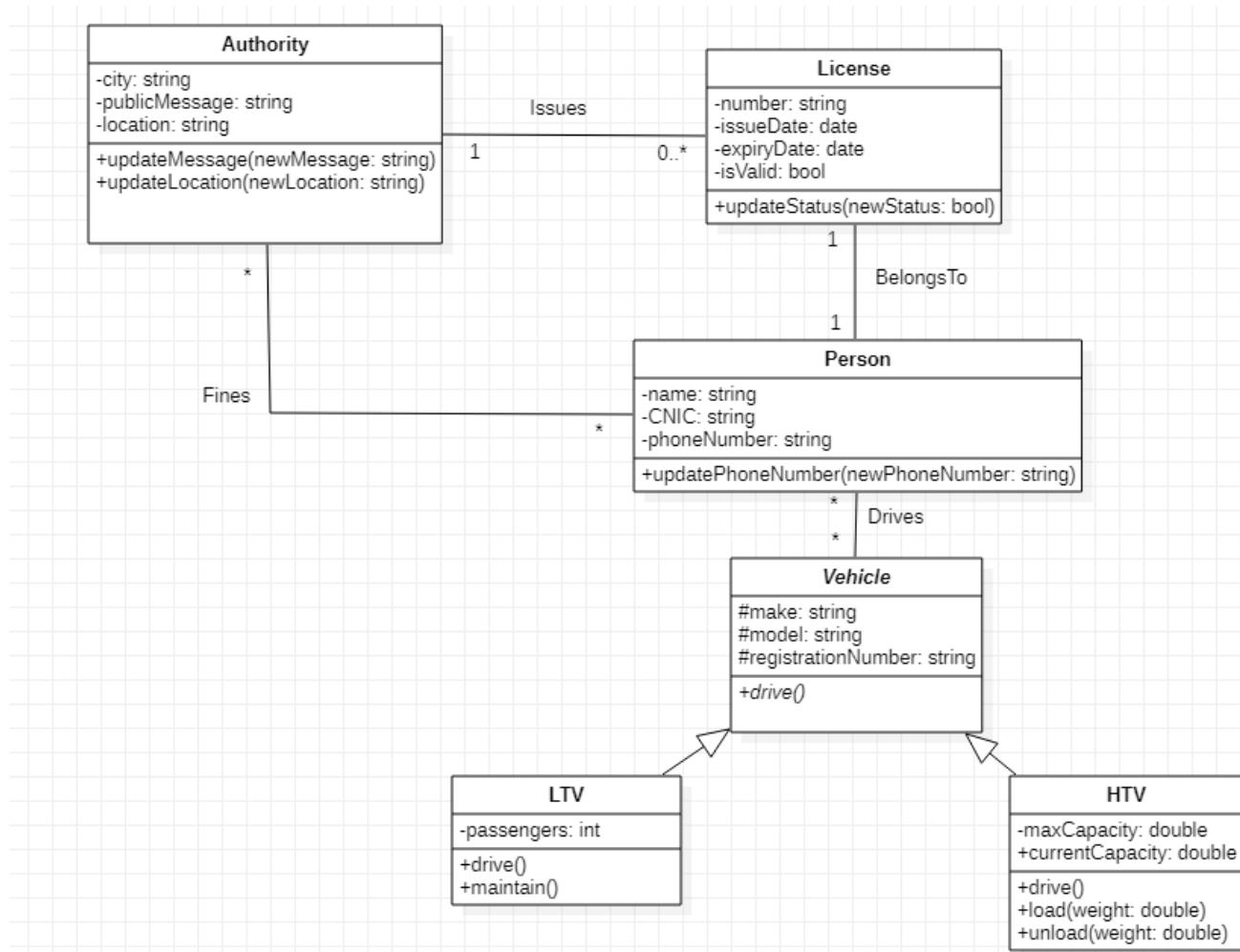
To approve the design for a company's new product, coordination is required amongst the different departments of the company. The marketing department first generates a raw idea which is then sent to the engineering department. The engineering department simulates the function of the product and then prepares a design. This design is then checked for durability by the testing department. At the same time, the customer service department checks the usability of the design. Once both of these departments have checked the design, the engineering department examines the results. If the results are satisfactory, the engineering department approves the design. Otherwise, the engineering department goes back to prepare a new design. The same steps are repeated until the design is finally approved.

Construct a **swimlane activity diagram** below for the product design approval process described above.

Question 3(Max. Marks = 10) [CLO 3]


Consider the design class diagram given above. It uses the Observer design pattern. When a shop object receives a `setDiscount()` message, it calls the `notify()` function which, in turn, sends the `update()` message to all registered customers. The customer objects then synchronize their state (`myDiscount`) with the state of the shop object (`discount`).

Draw a **design sequence diagram** below to show all messages passed between relevant objects when a shop object receives the `setDiscount()` message. Assume 2 customers are registered.

Question 4(Max. Marks = 10 = 1 x 10) [CLO 5]

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.

S#	Class	Metric	Value
1	Authority	Weighted Methods per Class (WMC)	
2	License	Weighted Methods per Class (WMC)	
3	HTV	Weighted Methods per Class (WMC)	
4	Vehicle	Depth of Inheritance Tree (DIT)	
5	LTV	Depth of Inheritance Tree (DIT)	
6	HTV	Depth of Inheritance Tree (DIT)	
7	Vehicle	Number of Children (NOC)	
8	LTV	Number of Children (NOC)	
9	Person	Coupling Between Objects (CBO)	
10	Vehicle	Coupling Between Objects (CBO)	

Name: _____

Roll Number: _____

Section _____

Question 5 (Max. Marks = 10) [CLO 5]

Consider the following code:

```
struct Pair {  
    Student* x;  
    Student* y;  
}  
  
void foo() {  
    Pair pr1 = Student::getPair();  
}  
  
void bar() {  
    Pair pr2 = Student::getPair();  
}
```

When function foo() calls getPair(), it gets a pair object containing (pointers to) two objects of the Student class. Afterwards, when function bar() calls getPair() it gets a pair object containing (pointers to) the same two Student objects again!

Use the space given below to write C++ code for the Student class that satisfies the description given above.

Important Note: Use a relevant design pattern.

National University of Computer and Emerging Sciences, Lahore Campus

	Course Name: Software Design & Analysis	Course Code: CS3004	
Program: BS (CS)	Semester: Fall 2021	Total Marks: 60	
Duration: Three hours	Weight:		
Paper Date: 10 Jan 2022	Page(s): 6		
Section: All sections			
Exam Type: Final			

Name: _____ Roll No. _____ Sec: _____

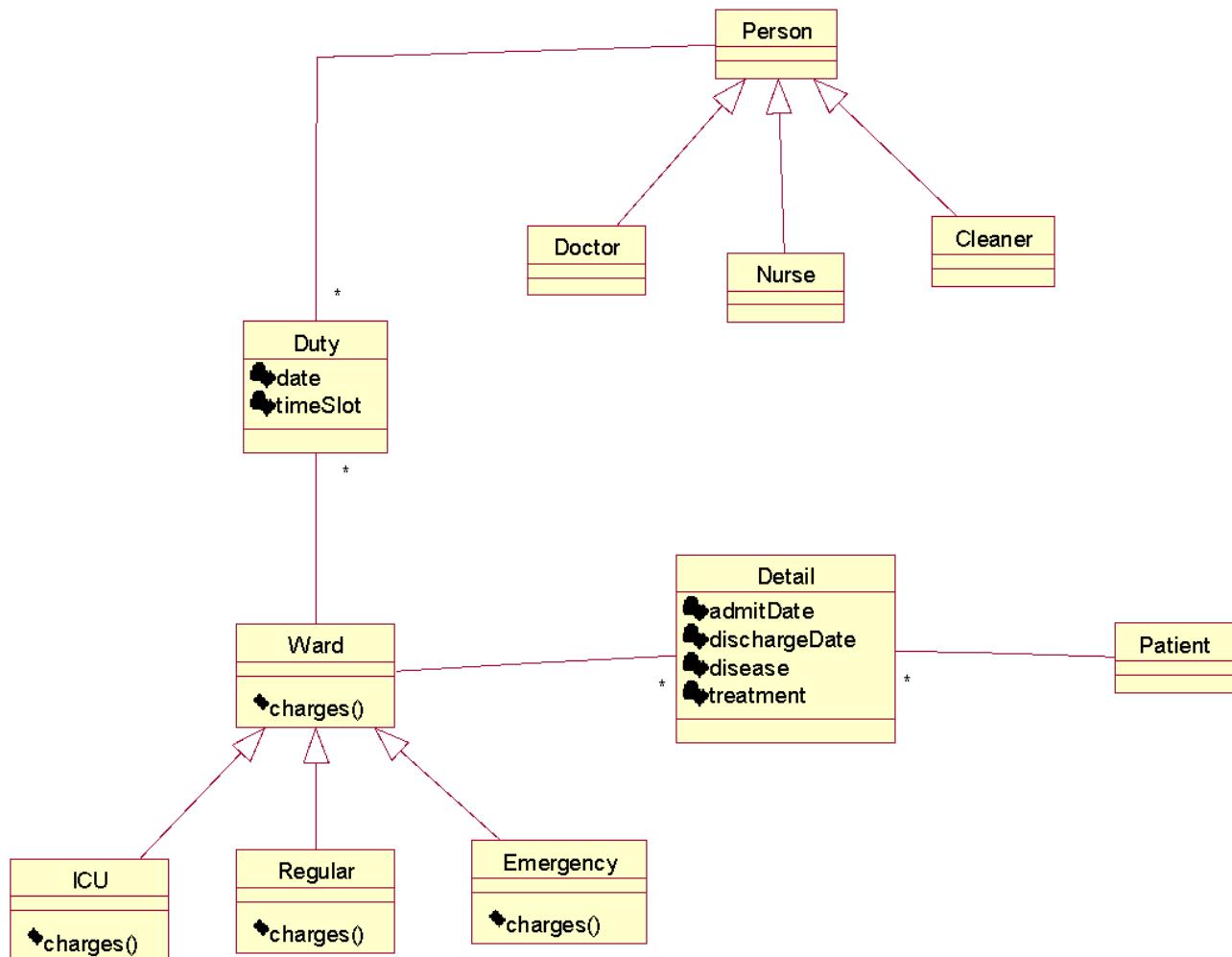
Question 1 (10 marks)

Consider the following system description:

A hospital wants to store basic information about patients, staff and admissions. Assume there are three types of staff: doctors, nurses and cleaners. A staff member can be assigned duty in any ward any time.

The hospital has three types of wards: emergency, regular and ICU. Each ward provides different services, and so has different charges. During the stay, a patient may move from one ward to another.

Give a class diagram showing classes, associations and multiplicity. Show any important data members or functions.



Question 2 (20 marks)

Consider a simple graphical diagram. A Graphical element in the graphical diagram can be a rectangle, a square, a line, or a simple graphical diagram. A simple graphical diagram may contain any number of rectangles, squares or lines. It may also contain one or more other simple graphical diagrams. Each graphical element has a unique alphanumerical serial number and it consumes a certain amount of area. The area covered by a line is equal to 1. The area consumed by a rectangle is equal to the product of its height and its width ; squares' area can be calculated by multiplying its side length. The area consumption of a simple graphical diagram is equal to the sum of the area of all the rectangles, squares, lines and simple graphical diagrams contained in it.

- (a) Which design pattern is suitable for designing the simple graphical diagram described above? [Note: An invalid answer to this part will result in a zero in the entire question.]
- (b) Draw a UML class diagram showing the design of the simple graphical diagram described above. This design must adhere to the structure of the design pattern chosen above.
- (c) Write code for all the classes. You can use either C++ or Java. Clearly mention your choice.

Question 3 (10 marks)

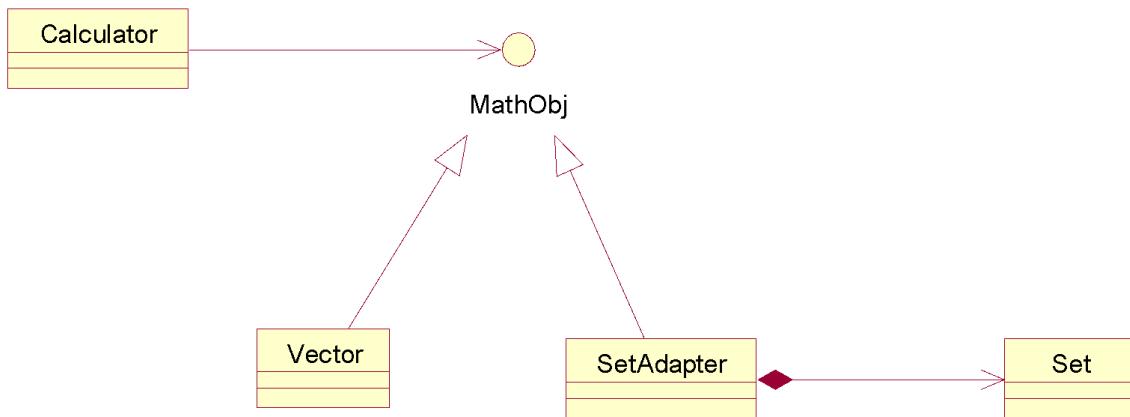
Consider the following class diagram:



The calculator performs various computations over the vectors.

(a) In future, we may add new classes (such as Matrix) in the system. So change the design to make it scalable (easy to maintain).

(b) A new class, say Set, is provided by an external vendor and cannot be changed. How would you incorporate this class? Show your design.



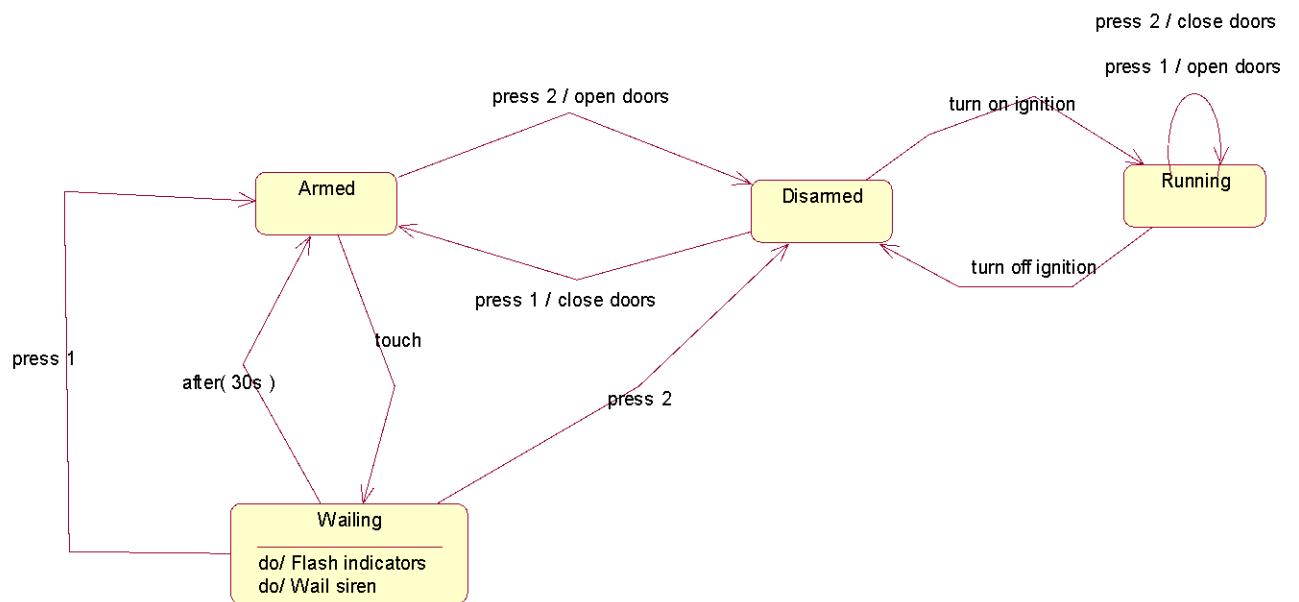
Question 4 (10 marks)

Consider a car security system (CSS) operated through a remote control. Assume the remote control has only two buttons: button 1, and button 2. Pressing button 1 arms the system, while pressing button 2 disarms the system. The system locks the doors on entering the armed mode, and unlocks the doors on entering the disarmed mode.

If someone touches the car while in the armed mode, the CSS enters the wailing mode. While in the wailing mode, the CSS continuously flashes the indicators and wails a siren. This wailing continues for 30 seconds, afterwards the CSS automatically stops wailing and returns to the armed mode. The wailing can be interrupted before 30 seconds by pressing either of the two buttons. If the button 2 is pressed then the next mode is disarmed, otherwise armed.

While in the armed mode or in the wailing mode, the driver cannot turn on the ignition. This can be done only in disarmed mode. When the ignition is turned on, the CSS enters the running mode; and turning off the ignition causes the system to go back to the disarmed mode. While in the running mode, pressing button 1 or 2 results in locking or unlocking the doors respectively; it does not change the mode.

Your task is to draw a UML state diagram for the afore-mentioned CSS.



Question 5 (10 marks)

Consider the following system:



A supplier may supply multiple parts, and a part can be provided by more than one suppliers.

Now give a sequence diagram to find all the suppliers of a given part (names required). You may add any functions required.

