

Software Design & Analysis Final Term Exam (CS3004)

Date: December 18 2024

Course Instructor(s)

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Total Time (Hrs): 135 Mins

Total Marks: 75

Total Questions: 3

Cutting and overwriting is not allowed. Marks shall be deducted otherwise.
Attempt neat & clean paper.
Attempt all the questions.

<Subjective Type>

	Q-1	Q-2	Q-3	Total
CLO	3	3	6	
Total Marks	25	25	25	75
Marks Obtained				

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

Question No. 1

(25 Marks)

Q1.1. Write three advantages of operation contracts. Write an operation contract of transferFunds operation in a banking application. (10 marks)

Advantages:

1. Identifies complex operations and implements them in readable way
2. It helps identify the instance creation, association and initialization of the instance attributes.
3. It describes the system's precondition, post-condition after a system has completed / or before execution of this process.

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Operation Contract: transferFunds

Field Name	Solution
1. Operation Name:	transferFunds (amount: double, depositor: string, receiver: string)
2. Reference	SSD?
3. Pre-condition:	<ol style="list-style-type: none"> 1. System is active with all connections set up. 2. user is in the transferFunds section. 3. Transfer details are correct.
4. Post condition:	<ol style="list-style-type: none"> 1. An instance t of transferFunds is created and associated with the related obj. Attributes of t are initialized (amount, depos, receiver etc) 2. Transfer funds is completed if no error. 3. System displays the success message returns to idle.

Q1.2. (4+4 Marks)

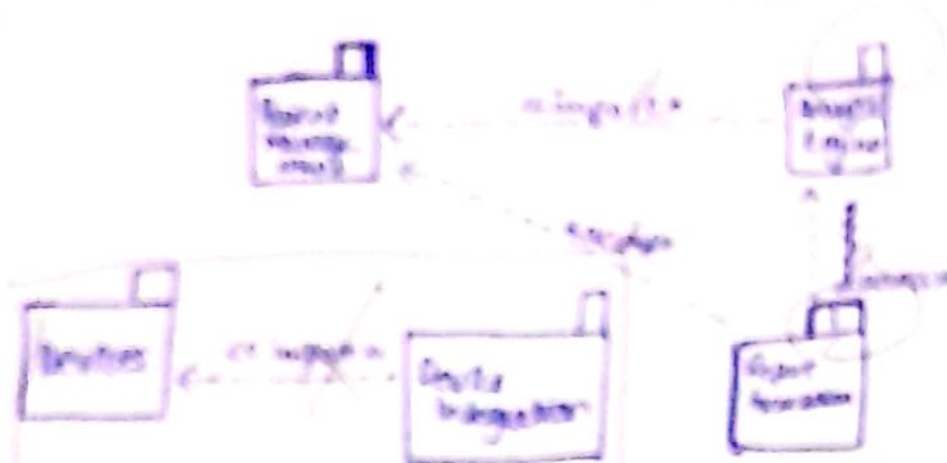
Differentiate between two types of dependencies available in package diagram (i.e. access and import), highlighting their meanings and use cases in software design.

Access	Import
<p>• Access refers that the public methods are being used from another package.</p> <p>Use case:</p> <ul style="list-style-type: none"> • Useful when viewing data only. • Useful when actual implementation is of no concern. 	<p>• Import means that all the methods of the other package are imported as private methods in the class importing it.</p> <p>Use Cases:</p> <ul style="list-style-type: none"> • When data dependencies are required, and all necessary methods are to be used and maybe modified.

Draw the package diagram for the given scenario to illustrate difference between access and import.

You are designing a Health Monitoring System with the following packages:

1. **PatientManagement:** Responsible for storing and managing patient information such as personal details and medical history.
2. **DeviceIntegration:** Manages the connection and data collection from wearable health monitoring devices, such as smartwatches and fitness trackers.
3. **AnalysisEngine:** Processes patient data and device readings to generate health insights, predictions, and alerts.
4. **ReportGeneration:** Handles the creation and delivery of detailed health reports for patients. It relies on the processed data from the AnalysisEngine and patient records from PatientManagement.



Q1.3. Explain the Singleton design pattern. Write a class below, apply Singleton design pattern on the member class of a library management system and return the member class of updated design (11)

UML Class Diagram for Member Class:

Member
memberId: int
name: string
phone: string
borrowBooks(): void
returnBooks(): void

In Singleton design pattern, we ensure that only a single instance of a class is created and we will use this instance through a global access point (usually implemented with getInstance() method for general use). Example: logger class, database connection etc.

In the above class (library management system), we can create a single instance of ~~Book~~ ^{Member} class which then can be used by member class to borrow that instance or return that instance. ~~One can create many only exists~~ through the getInstance() method whenever any class uses it.



Code Implementation:

```

class Member {
private:
    static Member instance
    = NULLPTR;
    Member() {} ;
public:
    static Member* getInstance() {
        if (instance == NULL)
        {
            instance = new Member();
        }
        return instance;
    }
}
    
```

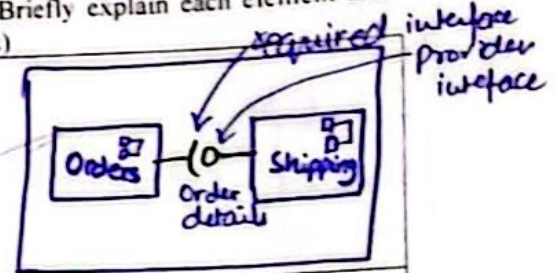
Here we have made the default constructor of our class private and created an instance that will be initialized only once and will be used globally using the getInstance() method that returns the instance when needed.

Question No. 2

Q2.1. Write down four main elements of a component diagram. Briefly explain each element and provide an example for each element using diagram only. (10 marks)

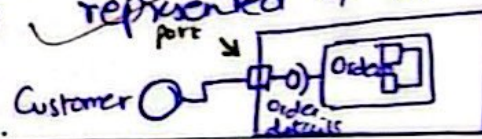
Element 01: Interfaces

- These represent how different components are providing and requiring information from other components.
- Example: An Shipping component requires order details from order component.



Element 02: Ports

- These are used by the components to communicate with the external actors represented by a circle.
- Example: Customer provides the order details to order component.



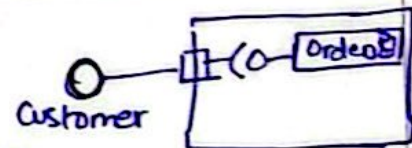
Element 03: Components

- They are actually combined into a single classes that are closely related to each other with related methods/ functionalities.
- Example: For example orders is a component that encapsulates all methods related to it.



Element 04: External Actors

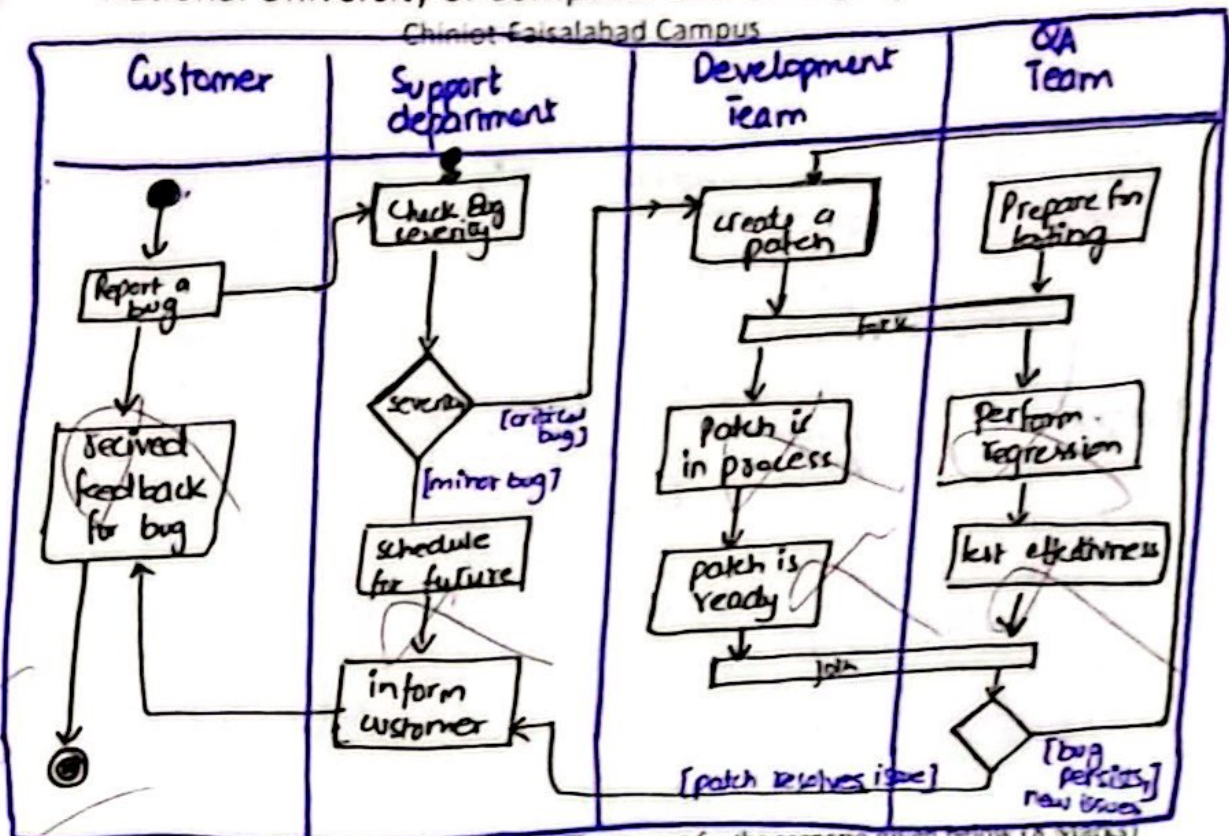
- They represent all the actors that are communicating outside the system boundaries and are not part of system itself.
- Example: A customer is an external entity/actor providing to a component of



Q2.2. Order.

When a customer reports a bug, the support department categorizes its severity while the development department investigate the root cause. For critical bugs the development team creates a patch, while the QA department prepares for testing. For minor bugs, the fix is scheduled for a future update. After the patch is ready, the QA department tests both the effectiveness and regression testing, performing these tasks in parallel. If the patch resolves the issue and passes testing, the support department informs the customer. If the bug persists or new issues are found, the process loops back to development for a reworked patch.

Construct a swimlane activity diagram for the scenario described above. (07 marks)



Q2.3. Design a State Diagram for a Smart Home Thermostat for the scenario given below (8 Marks)
A smart home thermostat regulates indoor temperature and operates in the following states:

1. Idle Mode:

- The thermostat is idle when no heating or cooling is required.
- It switches to Heating Mode if the room temperature falls below 18°C.
- It switches to Cooling Mode if the room temperature rises above 25°C.

2. Heating Mode:

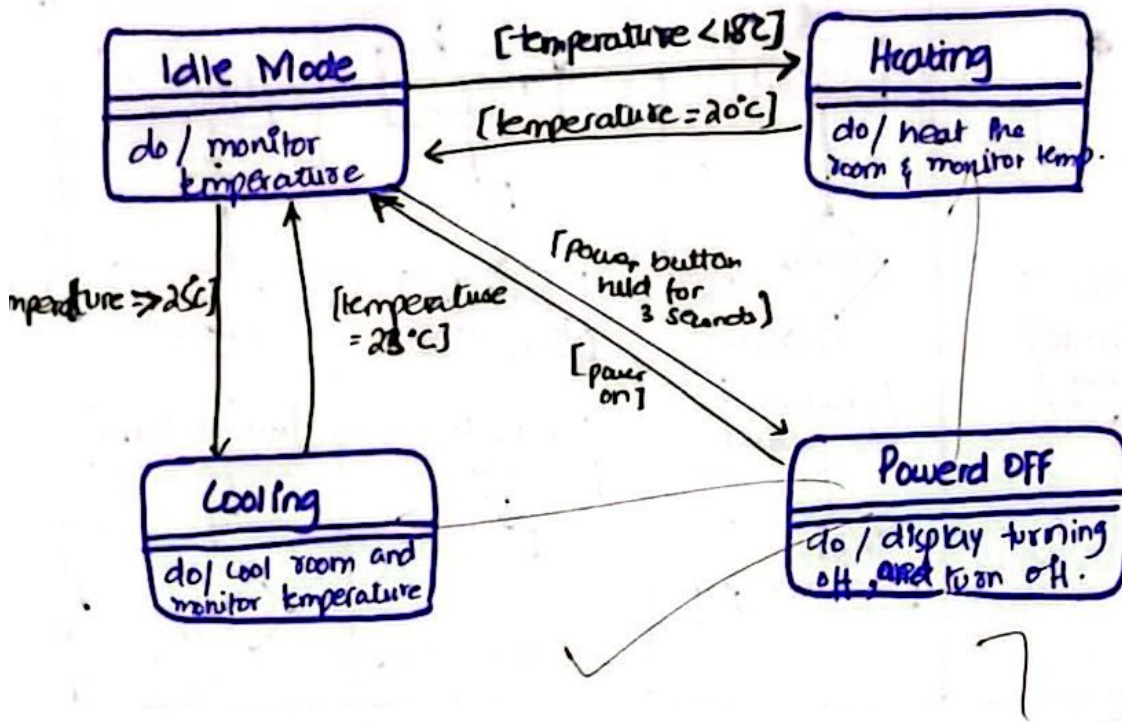
- This state is active when the room temperature drops below 18°C.
- The thermostat heats the room until the temperature reaches 20°C, then transitions back to Idle Mode.

3. Cooling Mode:

- This state is active when the room temperature exceeds 25°C.
- The thermostat cools the room until the temperature reaches 23°C, then transitions back to Idle Mode.

4. Powered Off:

- The thermostat turns off when the power button is held for 3 seconds.
- It switches to Idle Mode when powered on again.



CLO # 6: Develop software design artifacts based on requirements specifications

Question No. 3

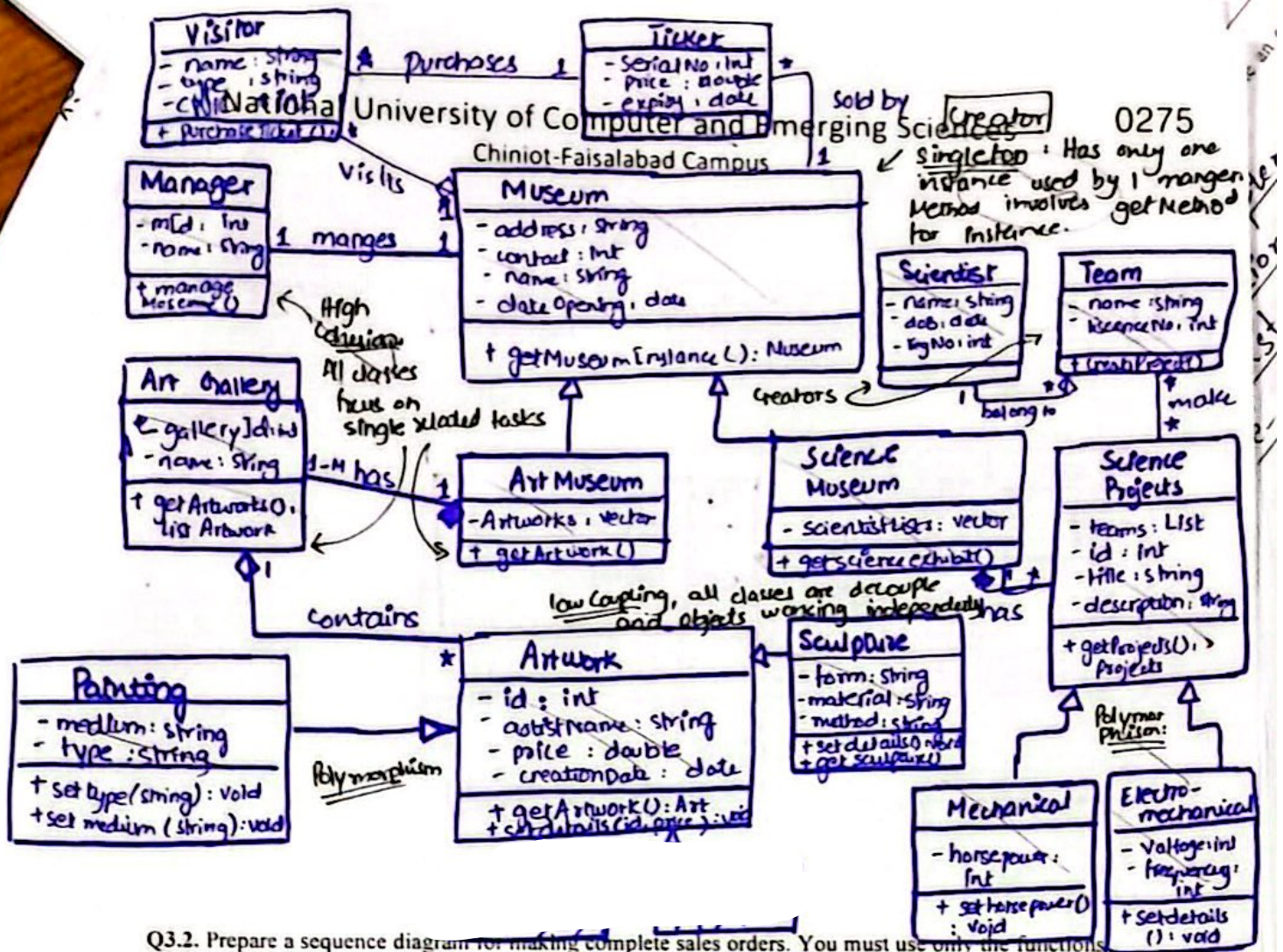
(25 Marks)

Q3.1. *do Singleton.*

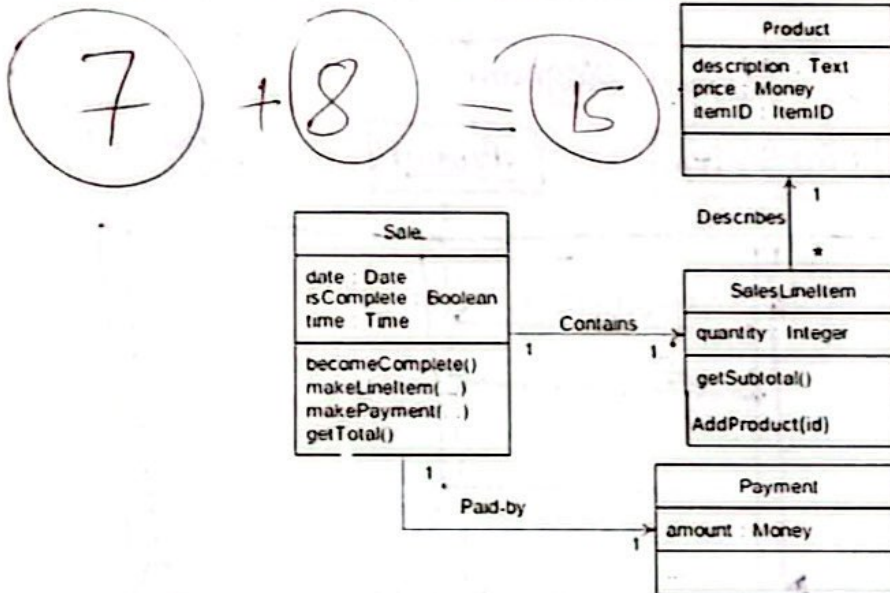
A manager manages a single museum. Every museum has an address, contact number, name and opening date. There are only two types of museums, i.e. art museums and science museums. Art museums house one or more art galleries whereas science museums house one or more science exhibits. Art galleries display multiple works of art. Artwork can be either a painting or a sculpture. All art works have a unique identification number (ID), 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. 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.

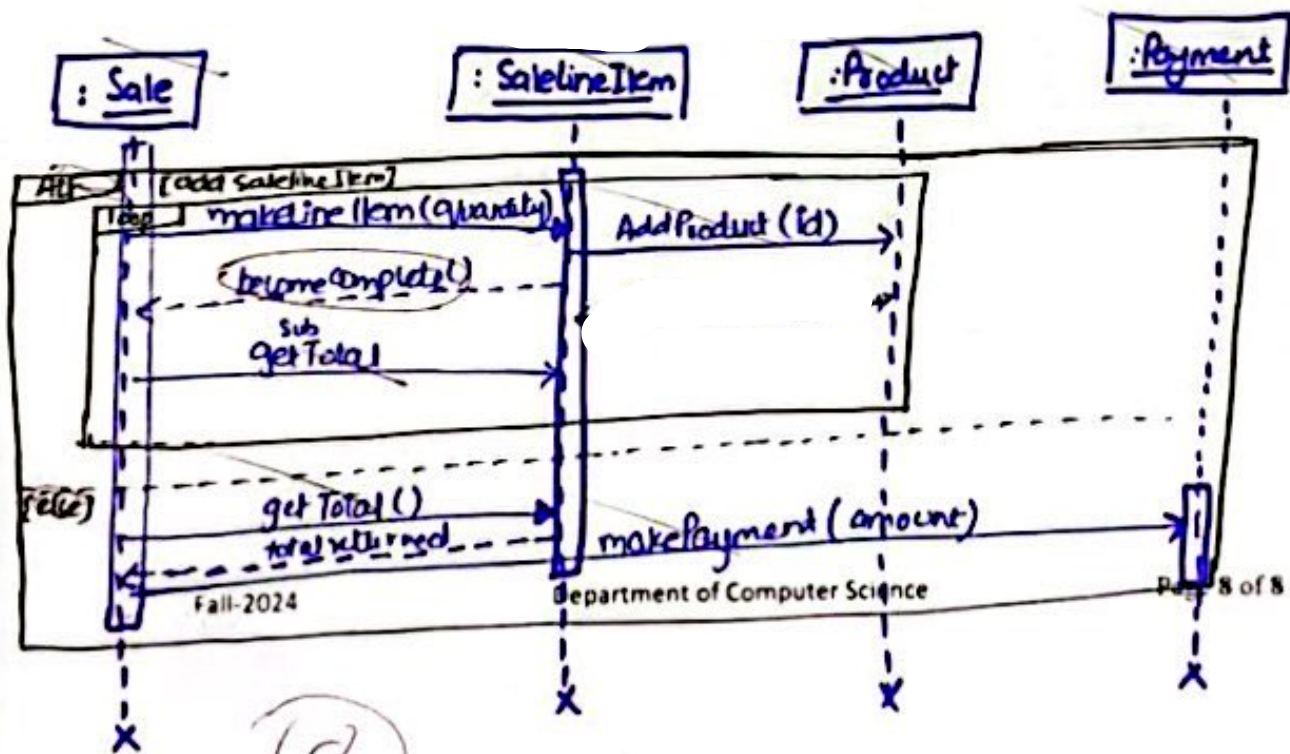
A. Model the information given above using a class diagram. (07 marks)

B. Ensure the GRASP principles (creator, low coupling, high-cohesion, polymorphism) are applied in the class diagram. Highlight each principle in the diagram as well. (08 marks)



Q3.2. Prepare a sequence diagram for making complete sales orders. You must use only the functions provided. You are not allowed to create new functions in any class. (10 Marks)





(8)