**Answer All Questions (Total 90 marks):**

Q1)

a) "Favor Composition over Inheritance" is one of the design principles, explain why and give an example. *(5 marks)*

b) Both the Observer and the Chain of Responsibility patterns attempt to decouple sending and receiving objects. Compare these two patterns with regard to such decoupling. *(5 marks)*

c) Draw class diagram for an immutable object. What are the pros and cons of using immutable objects? *(5 marks)*

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Q2)

a) Company X has a large amount of applications software written using a particular class library. Company Y that wrote the class library has now gone out of business. Company X buys a new class library from Company Z that provides the same functionality as the previous library, but unfortunately many of the classes have different interfaces. Company X does not have access to the source code for the old or the new library. What should Company X do?

Select the most appropriate design pattern to use to address the problem and show how it is applied. In particular, show an appropriate class diagram(s) and enough code fragments to illustrate your use of the pattern to solve the problem. *(10 marks)*

b) The designer of an adventure game wants a player to be able to take (and drop) various items found in the rooms of the game. Two of the items found in the game are bags and boxes. Both bags and boxes can contain individual items as well as other bags and boxes. Bags and boxes can be opened and closed and items can be added to or taken from a bag or box.

Select the most appropriate design pattern to use to address the problem and show how it is applied. In particular, show an appropriate class diagram(s) and enough code fragments to illustrate your use of the pattern to solve the problem. *(10 marks)*

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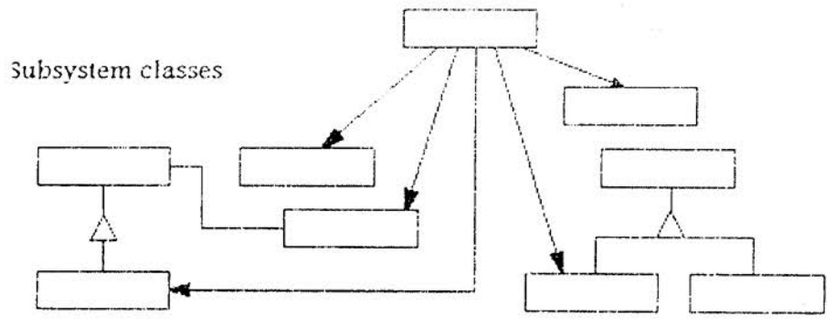
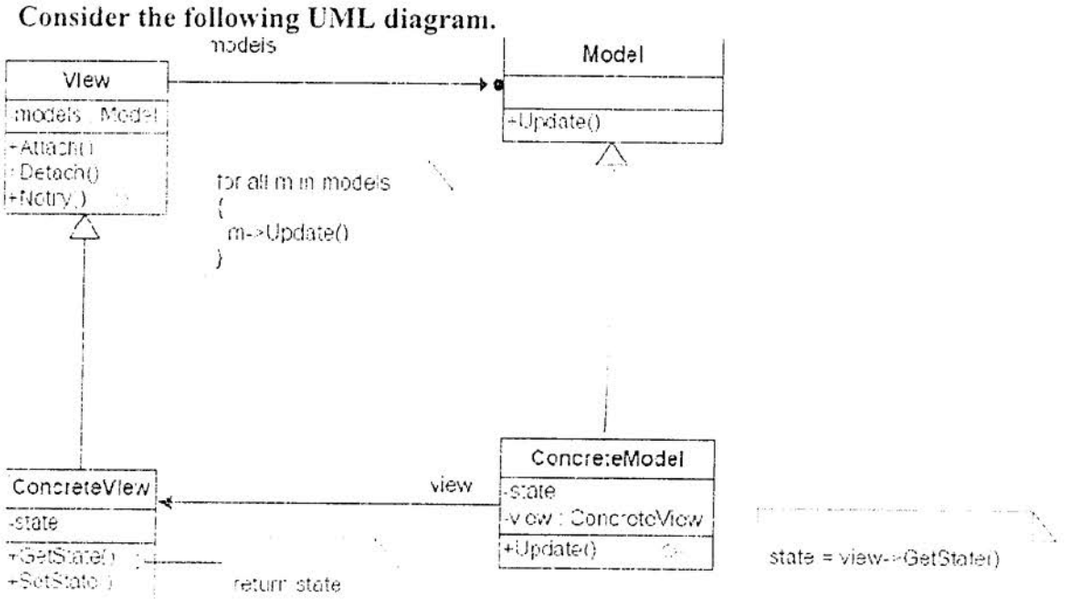
Q3)

a) Electrical equipments such as light bulbs and fans can be switched on or off. The actual operation when switching on or off includes different operation for different equipments. Identify a design pattern to model this operation. Draw the class diagram. *(5 marks)*

b) Consider the system diagram below. Which design pattern do you recognize here? When should this design pattern be applied? *(5 marks)*




c) **Consider the following UML diagram.**




i. **First, identify the pattern in the diagram.** *(2 marks)*
ii. **Second. identify the participants in the diagram and indicate their responsibilities.** *(3 marks)*

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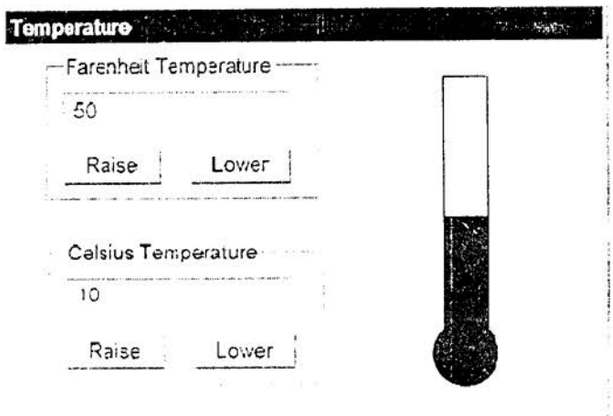
Q4)

**Consider the following application that allows the user to adjust the value of the temperature using the Raise and Lower button in the Celsius or Fahrenheit section of the GUI illustrated below. When a value is inserted the corresponding value in the other scale is displayed. Also the bar in the temperature gauge on the right is also adjusted accordingly.**




a) Which design pattern is most appropriate to be used in this application? *(3 marks)*

b) Please explain the GUI design by giving a class diagram *(7 marks)*

c) If one wanted to create a generic GUI application that may be used not only to convert Celsius to Fahrenheit temperature values but to do arbitrary conversions (e.g. centimeters to inches, kilograms to pounds, etc.) what additional design pattern would be most appropriate for achieving this flexibility, and how will it be used? Please show the enhanced design by giving a class diagram. *(10 marks)*

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Q5)

a) Company XYZ is offering cars in three product ranges: economy, medium and luxury. Design a system for XYZ that will help the car manufacturer to produce all this three ranges and handle different car models. Obviously, each model offer different options for things such as gearbox, wheels, color, stereo, etc.

   Use the abstract factory design pattern to implement such a system for XYZ. In particular, show an appropriate class diagram(s) and enough code fragments to illustrate your use of the pattern to solve the problem. *(10 marks)*

b) Opening a new connection to a Database Management system is usually an expensive operation. Most of the systems keep of a pool of available connections.

   i. Draw the Object Pool design pattern structure and explain its participants. *(5 marks)*
   ii. Write enough code fragments to show the implementation of the Pool Design Pattern to keep the released unneeded connections for future usage. *(5 marks)*