National University of Computer and Emerging Sciences, Lahore Campus

	Course Name:	**Formal Methods**	**Course Code:**	SE2003
	Degree Program:	**BS-SE**	**Semester:**	**Spring 2023**
	Exam Duration:	**3 Hours**	**Total Marks:**	**100**
	Paper Date:	**3rd June.2023**	**Weight**	**40%**
	Section:	**-**	**Page(s):**	**7**
	Exam Type:	**Final Exam**	**Instructor**	**Dr.Wafa Basit**

Student : Name:_____ Roll No._____ Section:_____

Instruction/Notes: Attempt all questions. Make necessary assumptions where required, Give justification for your answers. Don't use lead pencil. **Solve on the question paper. Draw neat and understandable diagrams**

Question # 1 (5+5+5+5+5)

a) **What is the difference between an FSA and a Petrinet?**

b) **What is the difference between Explicit and Symbolic Model checking?**

c) **What is a verification condition generator?**

d) **Does refactoring change the externally observable behavior of code?**

e) **What is the safety net for refactoring?**

Question # 2 Identify the bad smells in the following code. Also, mention and apply the suitable refactoring **(15 points)**

Before Refactoring	After Refactoring (Use UML notation)

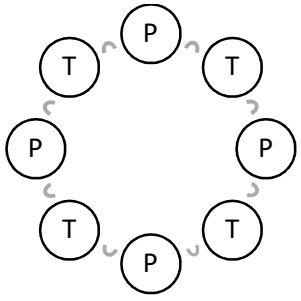
class Num{
int state;
String getString() {
switch (state) {
case 0 : // behaviour for state 0
return "zero";
case 1 : // behaviour for state 1
return "one";
case 2 : // behaviour for state 2
return "two";
case 3 : // behaviour for state 3
return "three";
}
}
}	

Question # 3(20 points)

Infosys Inc. is facing problems with reference to huge number of bug reports resulting in project delays due to increased testing and bug fixing time. So the management decides to use a variation of pair programming. Pair programming is **a software development technique in which two programmers work together at one workstation.** One, the driver, writes code while the other, the observer or navigator, reviews each line of code as it is typed in.

Info sys has decided to merge the testing and development teams such that each programmer is paired with two testers. But due to limited number of testers, they have to be shared. Each programmer either programs or reviews his/her code with the testers sitting beside him/her. So when ever both testers are available the programmer stops programming and get its code reviewed .A tester can review code of only one programmer at a time. The programmers and testers are made to sit on a round table to save time.

Draw a neat petrinet for the above problem given that there are 4 programmers and 4 testers. Which means that at any particular time only two programmers can get their code reviewed by the testers. Use a full sheet (landscape view) to draw the petrinet. Label your places and transitions such that they are self- explanatory.



Question # 4 (5+5+5+5+5 Points)

An organization has a system for keeping track of its employees while they are on the premises. Each employee is issued with an active badge which reports their current position to a central database. If the **set** of all people is **Person**, and the **set** of all locations is **Location**, then the information provided by the system may be described by a relation where is of type **Person↦Location**. It is impossible for an employee to be in two places at once, so this relation will be a partial function.

We use a Z schema to describe the structure of Persons' Locations, **Whereis** contains all information about employees and their location.

PersonLocation

$Whereis : Person \mapsto Location$

Note: Only write the success scenarios for each operation. Don't use the names of input and output variables that are same as the existing key words. Write necessary pre and post conditions

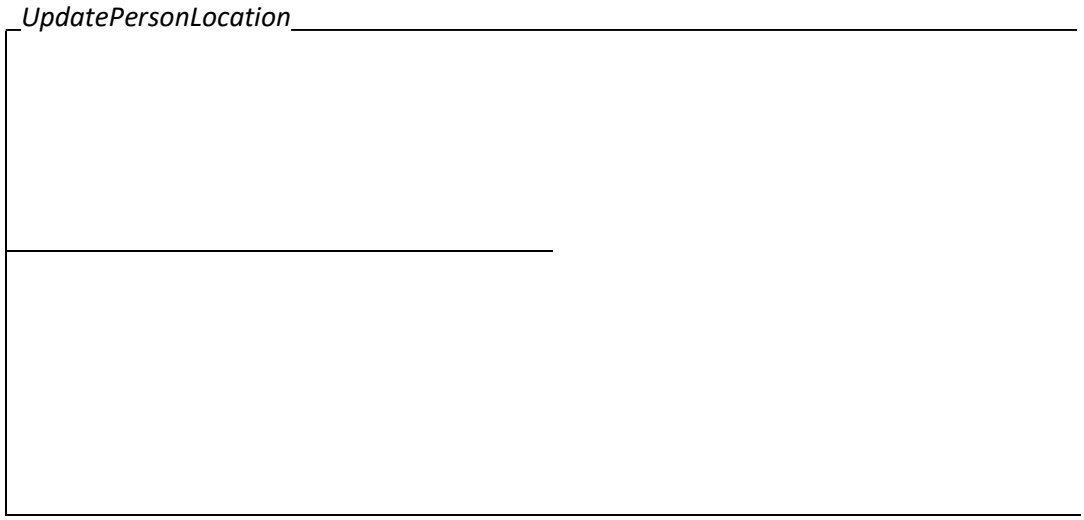
a) When a **PersonLocation** schema is initialized, it contains no information about location of any person, so the value of **Whereis** should be the empty function. The following schema describes the initial state of a **PersonLocation**

PersonLocationInit

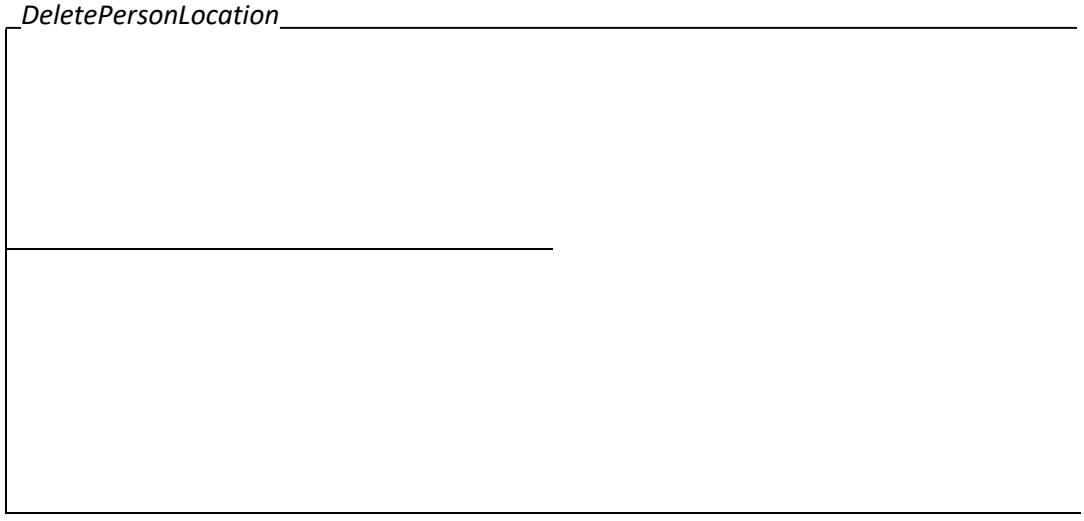
b) A successful retrieve operation requires an existing Person as input and provides the corresponding current Location as output. It leaves the system unchanged.

RetrievePersonLocation

c) A successful Update operation replaces the Location stored under an existing Person, and provides no output.

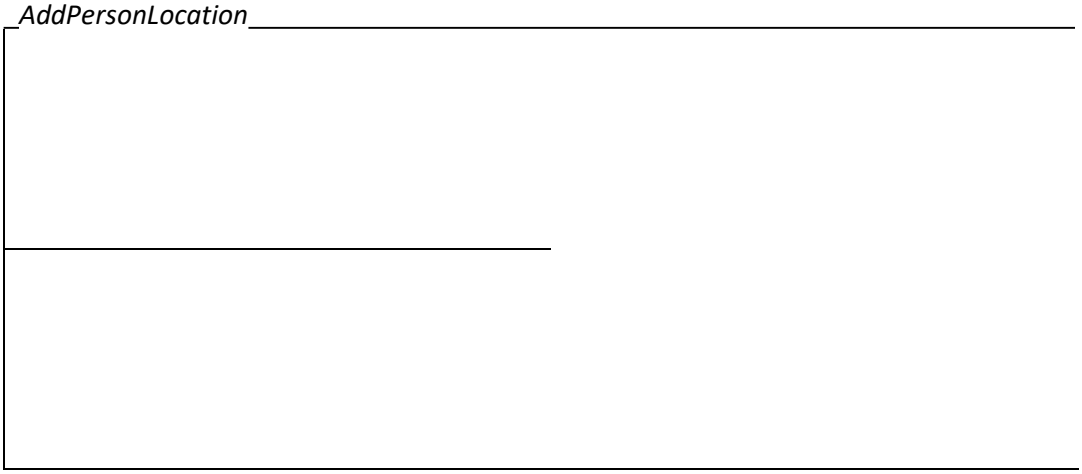


d) A successful delete operation requires that the Person in question exists. A single input is required, and the state of the system will change after the particular person's location will be deleted:



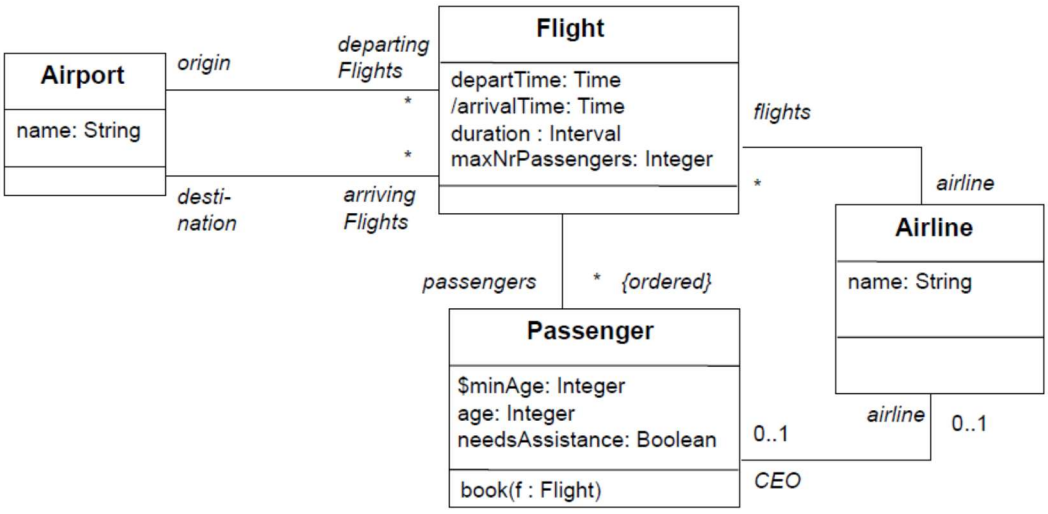
e) A successful add operation has a complementary precondition. This time, the Person P? must not be in the domain of PersonLocation. A new entry shall be made containing information about a new Person's Location.

AddPersonLocation



Question # 5 (3+3+3+3+3 Points)

Carefully analyze the following UML diagram. Write OCL constraints keeping in mind the concepts taught in the class.



a) Age of the CEO of the Airline is not less than 40 years

b) Arrival time of a flight is more than its departure time

c) Origin and Destination of a flight are not same

d) Count the number of all passengers in a particular flight that need assistance

e) An Airport should have an equal number of departing and arriving flights

Good Luck