



Final Term Examination – SPRING 2023

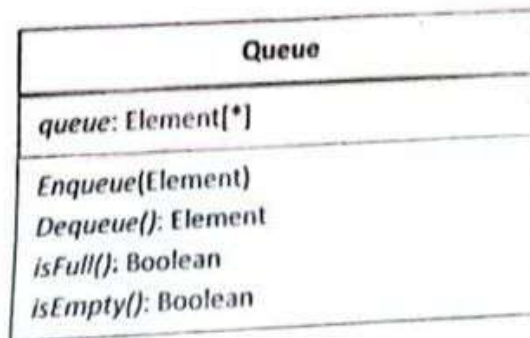
Course Title:	Formal Methods	Course	CSE356	Credit Hours	3(3,0)
Course Instructor/s:	Dr. Farooq Ahmad, Dr. Junaid Akram	Program	BS Software Engineering		
Semester:	4 th	Batch:	FA21	Section:	A, B, C
Time Allowed:	3 Hours		Date:	19 th June 2023	
Student's Name			Maximum Marks:	50	
Reg. No.					
Important Instructions / Guidelines: <ul style="list-style-type: none"> Answer all questions on the exam paper provided to you. Do not give multiple answers to a question. Cross out what you do not want me to read. Do not use the lead pencil. 					

Question 1:

[Marks: 3+3+4 = 10]

CLO: <3>; Bloom Taxonomy Level: <Applying>

A queue is an ordered list that obeys a first-in-first-out (FIFO) protocol. The queue is conceptualized as having items entering from the tail or rear while items leave the queue to the front or head. The operations that add and remove items from a queue are known as enqueue and dequeue respectively. Further, isEmpty and isFull are the operations to know whether a queue is full or empty. Apply the restriction on the number of elements in the queue to an integer SIZE. The UML specification of the Queue class is given below.



Formally model the Queue class in VDM-SL. A full explanation includes data types, free data types, a state, and operations.

[Marks: 3+3+4 = 10]

Question 2:

CLO: <3, 4>; Bloom Taxonomy Level: <Applying>

Let [PEOPLE] be the set of all possible persons and [SUBJECT] the set of all possible subjects. A specification for a university has a state schema:

University

students: PPEOPLE

subjects: PSUBJECT

enrolments: PEOPLE \leftrightarrow SUBJECT

dom enrolments \subseteq students

ran enrolments \subseteq subjects

For the class *University*, specify following operations, write your answer below in the form of Schemas:

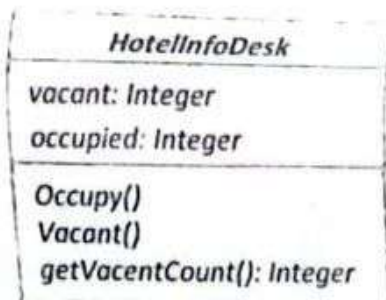
- Write an operation schema *newStudent* such that a person (*pers?*) becomes a student.
- Write an operation schema *studentLeaves* such that a person (*pers?*) which is not enrolled in any subject, is discarded as a student.
- Write an operation schema *personSubjects* which outputs the set of subjects (*subjs!*) in which the person (*pers?*) is enrolled.

Question 3:

[Marks: 4 + 6 = 10]

CLO: <3>; Bloom Taxonomy Level: <Applying>

A hotel information desk displays information about the number of occupied and vacant rooms. When an occupied room becomes vacant, the count of vacant rooms increases. When a vacant room is occupied, the count of vacant rooms decreases. Formally specify the *HotelInfoDesk* class in VDM-SL. Declare all types, the state, and operations given in the class diagram.



Question 4:

[Marks: 4 + 6 = 10]

CLO: <3, 4>; Bloom Taxonomy Level: <Applying>

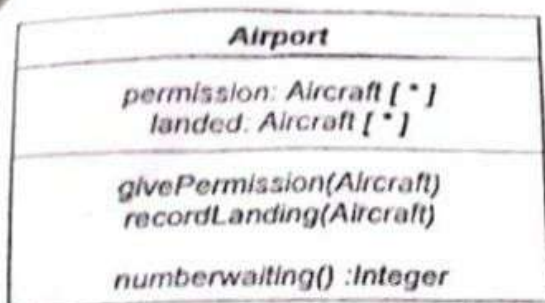
Formally specify the *Airport* class, given below, in Z language.

A system that keeps track of aircraft that are allowed to land at a particular airport. Aircraft must apply for permission to land at the airport before landing. When an aircraft arrives to land at the airport it should only have done so if it had previously been given permission. The invariant property for the system is the landed aircraft are those that have permission. Assume that the airport can land MAX number of aircraft that could be landed at any one time.

- Develop the state schema in Z.
- Develop the operation schemas in Z for the following operations:
givePermission: records the fact that an aircraft has been granted permission to land at the airport.
recordLanding: records an aircraft as having landed at the airport.
numberWaiting: returns the number of aircrafts granted permission to land but not yet landed.

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The UML specification of the Airport class is given below:

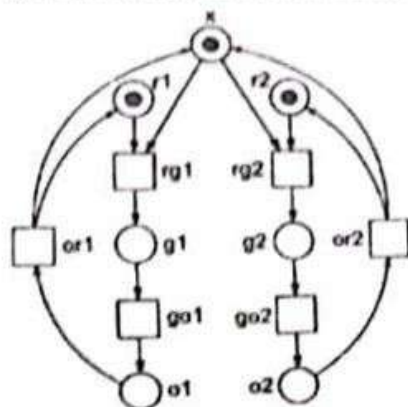


Question 5:

[Marks: 4 + 1 + 2 + 3 =10]

CLO: <3, 4>; Bloom Taxonomy Level: <Applying>

A Petri net model for two traffic light signals is given below:



- Generate the reachability graph of net given below
- Is the Petri net given below bounded, if yes then what is the bound?
- In which respect does the model, in the figure above, fail?
- Repair the model in the figure such that, after the first traffic light turns red, only the second traffic light can turn green, and vice versa.