COMSATS University Islamabad, Lahore Campus

☐ **Sessional-I**   ■ **Sessional-II**   ☐ **Terminal Examination** – **Spring 2021**

Course Title:	Formal Methods			Course	CSE356	Credit Hours:	3(3,0)
Course Instructor/s:	Dr. Farooq Ahmad			Programme	BS Software Engineering		
Semester:	4th	Batch: FA19-BSE	Section:	A, B	Date:	04th May, 2021	
Time Allowed:	**90 minutes**			**Maximum Marks:**		**20**	
Student's Name				Reg. No.			

Important Instructions / Guidelines:
- 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: 2+2=4]

I. The bank keeps details of its customers, and Customer is the given set of customer details viz. [*Customer*] and *details: AcctNo ↔ Customer* is the relation that gives the customer details for a given account number. Let *current:* $\mathbb{P}$ *AcctNo* is a set of current accounts. Write down an expression that gives the customers' detail which are holding current account.

II. For the relations *details: AcctNo ↔ Customer*, if c: *Customer* is a particular customer, write down a predicate to formalize the requirement that the account numbers associated with customer c can't be more than 3.

Question 2: [Marks: 2+1+3=6]

For a function *lent_to*: Book ↛ Person in a library system:

a) write down an expression for the set of library books on loan to a person *p*: Person.
b) What does your expression return, if *p* is not a member of *borrowers* where *borrowers*: $\mathbb{P}$ Person?
c) Write down a predicate to formalize the requirement that nobody shall be allowed to have more than five books on loan.

Question 3: [Marks: 2*5=10]

A database of the application of wholesaler can be modelled using the relations *price*, *in_stock* and *supplies*. *Price* is a relation over *Products* $\times 1\ldots20$, which models the association between prices and stock items. *In_stock* is a relation over *Products* $\times$ **N,** which models the association between stock items and the current number in stock of product. *Supplies* is a relation over *Suppliers* $\times$ *Products* which models the relation between a supplier and the product that is delivered by that supplier. If the current value of these relations are following:

price = {(nut, 3), (bolt, 5), (screw, 1), (board, 17), (fastener, 12)},

in_stock = {(nut, 500), (bolt, 2100), (screw, 45), (board, 0), (fastener, 500)},

supplies = {(Thomas, nut), (Thomas, bolt), (Wilks, bolt), (Wilks, screw), (Wilks, board), (Wilks, fastener), (Rogers, board), (Rogers, fastener)}

Write the expressions:

a) To provide the list of products that have a price range between 1 to 5.
b) To provide the list of products supply by Wilks.
c) To provide the list of suppliers that supply the product bolt and board.
d) To provide the list of products and their quantity whose stock is between 0 to 500.
e) To provide a list of suppliers only.