# M.E. 1st Semester (CST) Final Examination, December 2011
# Symbolic Logic & Logic Programming (CST-910)

Time- 3 Hours | Full Marks-70

**FIRST HALF**

Answer Question 1 and ANY TWO from the rest.

1. Answer *any five* from the following: (5×3)

a) *If today is Sunday, then people will not go to work.*
How to make this argument *sound*?

b) Write clauses and resolvent for the formula:- $P(x) \vee \neg Q(f(x), b) \vee P(g(y))$

c) PHILOSOPHER ($a$)→SCHOLAR($a$):- Using first order predicate logic show that the claim "If $a$ is a philosopher then $a$ is a scholar" is false.

d) If φ and ψ are formulas, then write all other formulas using φ and ψ after applying quantifiers and logical operators.

e) Write equivalent formulas using existential quantifiers for the following :-
(i) ∀x ¬Love(x,Saddam) (ii) ∀x Love(x,Princess-Di)

f) Prove that following two propositions are not equivalent:
(i) "John *and* Charles are brothers"
(ii) "John is a brother" *and* "Charles is a brother."

2. Consider a set of people '$n$' and the following *predicates*

(i) F($n$, $m$) denotes $n$ is a friend of $m$
(ii) L($n$, $m$) denotes $n$ likes $m$
(iii) H($n$, $m$) denotes $n$ hates $m$

*Symbolize the following statements into First Order Predicate Logic.*

a) No one hates himself/herself

b) Everyone has at least one friend

c) Not Everybody likes his/her friend

d) If '$a$' is a friend of '$b$' and '$b$' is a friend of '$c$' then '$a$' too must be a friend of '$c$'.

e) If '$a$' is a friend of '$c$' then there exists a person '$b$' such that '$a$' is a friend of '$b$' and '$b$' is a friend of '$c$'. 10

3. a) Obtain the *prenex normal* form of the following:-
$\forall x \forall y(\exists z P(x,y,z)) \wedge \exists x \exists u(Q(x,u) \rightarrow \exists y \exists w Q(y,u))$

b) Why TRUTH TABLE methods are not useful for obtaining interpretation of a formula in *First Order Predicate Logic*? 5+5

4. Write the steps to transform *Prenex Conjunctive Normal Form* (PCNF) well formed formula to *Skolem Standard Form* and its application in real life problem. 5+5

## SECOND HALF

Answer Question 5 and ANY TWO from the rest.

5. Answer *any five* from the following.
   a) Write a PROLOG program to append two lists into a third list. Use the append program to determine whether an element is a member of a list. [1.5 + 1.5]
   b) Write a PROLOG program to determine length of a list. Trace the length program for the goal: ? length ( [a, b], L ). [1.5 + 1.5]
   c) Use an accumulator to find factorial of a positive integer N in a PROLOG program. What was the advantage of using accumulator in your program? [2 +1]
   d) Illustrate the difference between green cut and red cut by writing suitable PROLOG programs. [3]
   e) Write two different PROLOG programs to find union and difference between two sets represented as PROLOG lists. [1.5 + 1.5]
   f) Discuss different representations of trees (including binary tree) in PROLOG with appropriate examples. [3]
   g) Write a PROLOG program to obtain post order traversal of a binary tree. [3]

6. a) Let L and L1 denote two lists of terms. Write PROLOG program to delete all occurrences of X in L, giving the result in L1.
   b) Given is a list of arcs in the form [ arc(3,2), arc(4,1),.....]. Write PROLOG programs to perform the following tasks:
      i) Test if the arcs in the given list can be rearranged into a continuous path of the form [ arc(3,2), arc(2,4), arc(4,1),...], and if so, return the continuous path.
      ii) Test if the arcs in the given list form a cycle, that is, a continuous path of which last arc can be joined to the first one. [2 + 4 + 4]

7. a) Implement the following sorting routines in PROLOG:
      i) Insertion Sort.
      ii) Merge Sort.
   b) Three musicians of a multinational band take turns playing solo in a piece of music: each plays only once. The pianist plays first. John plays saxophone plays before the Australian. Mark comes from the United States and plays

before the violinist. One soloist comes from Japan and one is Sam. Write a PROLOG program to find out who comes from which country, plays what instrument, and in which order. [(2 + 3) + 5]

8. a) One way of representing the positive whole numbers in PROLOG terms involving the integer 0 and the functor s with one argument. Thus, we represent 0 by itself, 1 by s(0), 2 by s(s(0)), and so on. Write definitions of arithmetic operations addition (plus), subtraction (difference), multiplication (times). Draw a tree to show how would the goal times(U, V, W) would behave? What is your conclusion about the output? Also define the predicate "less than or equal to" for the given number system.

b) The Ackerman number used in mathematical logic can be calculated using the formula shown below:

$$A(M, N) = \begin{cases} N+1, & \text{if } M=0 \\ A(M-1, 1), & \text{if } N=0 \\ A(M-1, A(M, N-1)), & \text{otherwise.} \end{cases}$$

Write a PROLOG program to determine the Ackerman number given M and N. [(1.5 x 3 + 1.5 + 0.5 + 1) + 2.5]