CE8-R3: LOGIC AND FUNCTIONAL PROGRAMMING

NOTE:

1. **Answer question 1 and any FOUR questions from 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Time: 3 Hours **Total Marks: 100**

1.

a) Comment on the following statement: "In logic programming, a program is used to generate a result based on a certain input can also be used to check that a certain input value generates a particular result". Discuss how existing programming languages approximate this general statement.

b) Explain the modus ponen inference rule with the help of an example.

c) Show that the FOL formula $\forall y \exists x\, p(x,y) \rightarrow \exists x \forall y\, p(x,y)$ is satisfiable but not valid.

d) Explain the each of the statement and the output of the following segment of a ML program.

```
Let   val x = ref 6
      val y = x
      x := 7
in
      !y
```

e) Express the negative fact "john does not like snakes" in Prolog by using system defined cut (!) and fail predicates.

f) Explain curried function and its use in functional programming environment.

g) Elaborate Recursion in the lambda calculus with example.

(7×4)

2. Let $\sum$ = {zero, succ, pred, plus} be a signature. Let I be the interpretation in Z, the set of integers such that I(zero)=0, I(succ)=λx[x+1], I(pred)=λx[x-1] and I(plus)=λ(x, y) [x+y].

a) Define the set of normal forms (subset of T_Σ).

b) Define rewrite rules to compute the normal form of each term.

c) Define the Unique $\sum$ -homomorphism $h_z : T_\Sigma \rightarrow Z$.

d) Let I` be another interpretation in E, the set of all even inters with I` (zero) = 0

I` (succ) = λx[x+2], I` (pred) = λx[x-2] and I (plus) = λ(x,y)[x+y]. Show that the two interpretations are isomorphic.

(4+4+4+6)

3.

a) Explain the differences between declarative and imperative computing paradigms.

b) Give a procedure to convert Predicate Calculus Formulae into prenex normal form.

c) Consider the following facts:

Marcus was a man. Marcus was a Pompeian. All Pompeians were Romans. Caesar was a Roman ruler. All Romans were loyal to Caesar or hated him. Everyone is loyal to someone. Men only try to assassinate rulers. Marcus tried to assassinate Caesar.

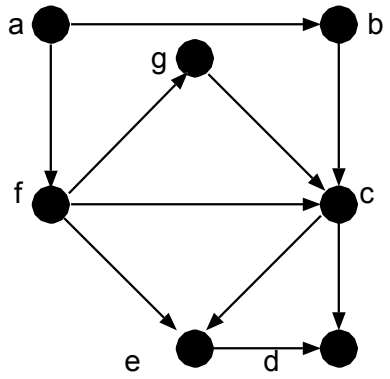
Using Resolution theorem proving prove that “Marcus hated Caesar”

(4+5+9)

4.

a) How do we define a function in Prolog? Explain with the help of an example.

b) Write a Prolog program which describes the following directed graph. Give a rule to check connected nodes.



c) Write a Prolog code for Quick Sort

d) What do you mean by "Lazy Evaluation"? Elaborate with the help of an example.

(4+4+6+4)

5.

a) What do you mean by Unification? What is a most general unifier (mgu)?

b) Find the most general unifier for

f(X, g(a,z,w), a,h(X,b,w))

and *f(h(a,z), g(a,h(z,b),X),z,h(d,b,a))*

c) Transform the following predicate formula into its equivalent **skolem conjunctive normal forms**.

$$\forall x\{\sim R(x) \rightarrow P(a) \wedge \exists z \sim \theta(z,a)\} \vee$$

$$\forall x\{P(x) \rightarrow \exists y \theta(y,x)\}$$

(4+6+8)

6.

a) How do functions in lambda calculus are different from those in imperative programming languages?

b) Write λ - abstraction, which generates λ - function for computing successor or predessor of a number.

c) Use Lambda Calculus to perform the following tasks:

i) Breadth-first traversal of a tree.

ii) Construction of a binary search tree from a given list of elements.

iii) Addition of an element in an existing binary search tree.

(2+3+[5+4+4])

7.

a) What is operator overloading? How is it different from polymorphism in SML?

b) Give a function for Merge sort in SML.

c) What do you mean by signatures in SML? Explain with an example.

(6+6+6)