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) Describe the basic characteristics of a functional language.

b) What do you understand by sharing Constraints in SML? Explain with example?

c) Differentiate between the use of cut and fail in PROLOG.

d) Write a function merge in PROLOG to merge two sorted lists.

e) What do you understand by lazy evaluation? How is it beneficial?

f) What is skolemization? Can we drop off all quantifiers?

g) How do we convert a wff to prenex normal form?

(7x4)

2.

a) What is Refutation Strategy? Consider the following argument:
If the violinist plays the concerto, then the crowds will come if the prices are not too high.
If the violinist plays the concerto, then the prices will not be too high.
Therefore, if the violinist plays the concerto, the crowds will come.
Is this argument valid, i.e. does the conclusion (the third statement) follow logically from the premises (the first two statements)? Check the consistency of using a truth table.

b) Prove {P} |- (~Q $\rightarrow$ ~ (P $\rightarrow$ Q)) using Axiomatic system.

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.

(6+6+6)

3.

a) Elaborate recursion in the lambda calculus with the help of an example.

b) Write recursive and iterative PROLOG programs for factorial of number n.

c) Explain, how unification can be performed for function applications, parameters and variables. What is Occurs check in Unification? Can you unify?
   i) g(?a, f(?c)) with g(f(?b), ?a)
   ii) g(?a, f(?a)) with g(f(?b), ?b)

(4+6+8)

4.

a) When are two λ – terms considered congruent? When is a term considered to be in normal form?

b) Prove by Resolution Refutation the following:
$\{ (p_i \rightarrow p_j) , (\neg (p_j \rightarrow p_k) \rightarrow \neg p_j) \} \models (p_i \rightarrow p_k)$

(8+10)

5.

a) Evaluate the following lambda expressions using *eager*.beta-reduction (use the standard interpretations for numbers and Booleans wherever needed).

i) $((\lambda x \cdot x * x)5)$

ii) $((\lambda y \cdot ((\lambda x \cdot x + y + z)3))2)$

iii) $(\lambda y \cdot (\lambda w \cdot w)((\lambda x \cdot x)y(\lambda z \cdot z)))$

b) Find the most general unifier for the following set:
S = { A(x, z, g(x, y, f(z))), A(y, f(x), w) }

(9+9)

6.

a) Give the function for Quick sort in SML.

b) Convert the following to prenex normal form and then Skolem Standard form
(∀x) (∀y) (∀z) (A(x,y,z) V B(y)) → (∀x) C(x,z)

(9+9)

7.

a) Show with example how two lists can be concatenated in
i) in an imperative language
ii) in a functional language
iii) in a declarative language

b) Consider the clauses.

```
male(albert).
male(edward).
female(alice).
female(victoria).
parents(edward,victoria,albert).
parents(alice,victoria,albert).
sister_of(X,Y) :-female(X),parents(X,M,F),parents(Y,M,F).
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Show all steps which PROLOG takes to reply to the query.

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?- sister_of(alice, edward).
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(9+9)