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) Prove the theorem "from (P V Q, ~ P) infor Q" using Natural Deduction System.

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

c) Define signature and functions in functional programming in brief.

d) What is Resolution Principle? Explain with the help of an example.

e) Write a function in SML to generate nth term in the Fibonacci series.

f) What is Refutation? Explain in your own words.

g) Give three situations where lazy evaluation is preferred over eager evaluation. Explain through example.

(7×4)

2.

a) When do we use functional languages? What are the basic characteristics of a functional language?

b) What are the differences between let and local constructs in SML? Explain with example.

c) Find the values of the following λ-expressions and show the evaluation steps.
   i) $(\lambda x.x 5)\, (\lambda y.y*6)$
   ii) $(\lambda x.xy.x*y)4$

d) Write a λ-function to find common elements of two lists. Use functions such as null, car, cdr, cons etc. for manipulating lists.

(5+4+4+5)

3.

a) What do you mean by Free variables? Why do we need substitution?

b) What do you mean by Reduction Order? Does the order in which redexes (reducible expressions) are chosen matter? Can two terminating reductions give different answers? What is Common Evaluation Orders?

c) Elaborate Recursion in the lambda calculus with example.

d) Write the expression $(x*3)*2 - (x*3)/5+((x*3)+4)$ using λ-notation.

e) What do you mean by Referential Transparency?

(2+6+4+3+3)

4.

a) Give a procedure to convert Predicate Calculus Formulas into Clausal Form.

b) Convert the following expression into clausal form.
   $\exists x\, \forall y\, (\forall z\, P(f(x), y, z) \to (\exists u\, Q(x, u) \wedge \exists v\, R(y, v)))$

c) If parent(X, Y) means X is a parent of Y then write the following relationship in Prolog.
   (i) Father (ii) grandparent (iii) greatgreatgrandparent (iv) ancestor

d) Write a prolog program to sort a list in ascending order using quick sort technique.

(5+5+4+4)

5.
a) Explain Unification and Resolution techniques with suitable example?
b) For a triangle ABC, it is given that the sum of the interior angles: $\angle A + \angle B + \angle C = 180$ degrees. Show by resolution theorem that the exterior angle is the sum of the opposite interior angles.
c) Show that the following formula is valid:

$(A(x) \vee B(y)) \rightarrow C(Z) \Rightarrow (\neg A(x) \wedge \neg B(y)) \vee C(Z)$

Where X, Y and Z are variables and A, B and C and predicates.

(6+8+4)

6.
a) What do you mean by Non-Strict Functional Languages? What are the advantages?
b) What do you mean by duplication of effort? Explain with an example.
c) Lazy Evaluation is also referred to as "call by need". Elaborate with an example.
d) What is the overhead cost of building an object to represent delayed actual parameter? What is the practical benefit of it?
e) Discuss Strictness Analysis.

(3+3+4+4+4)

7.
a) What is overloading? How is it different from polymorphism in SML?
b) Write a function for Insertion sort in SML.
c) Define node, path, leaf, and depth of a tree datatype. What are the different ways to convert trees into lists?
d) Write a SML program to compute GCD.
e) SML does not support array representation support a scheme for array representation in SML so that any index value of an array can be retrieved in atmost $(\log_2 N)$ time, where 'N' is the number of elements in an array.

(3+4+4+3+4)