

## CE8-R3: LOGIC AND FUNCTIONAL PROGRAMMING

### NOTE:

1. Answer question 1 and any FOUR from questions 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) Compare functional programming and procedural programming.
- b) A set of clauses  $S$  is unsatisfiable iff there is no Herbrand model for  $S$ . Prove.
- c) How powerful is the Semantic Tableaux system?
- d) Why do we call Prolog a declarative language? What is a logical variable?
- e) Represent the following function using lambda calculus:  $f(x)=x+2$  for every  $x$ .
- f) Write an implementation of currying operation.
- g) Suppose that we generalize "pairs" in the Lambda Calculus to "triples" by defining:

$$\text{triple} = \lambda a. \lambda b. \lambda c. \lambda t. t a b c$$

Define selectors *first*, *second*, and *third* in the Lambda Calculus, such that:

$$\text{first} (\text{triple } x y z) \rightarrow x$$
$$\text{second} (\text{triple } x y z) \rightarrow y$$
$$\text{third} (\text{triple } x y z) \rightarrow z$$

(7x4)

2.

- a) Give five reasons in favour of functional programming.
- b) What is pure function? Give characteristics of a function.
- c) What do you mean by a higher-order function? Give example.
- d) Compare lazy and eager evaluation strategies with suitable examples.

(5+3+4+6)

3.

- a) What is Semantic Tableaux? Explain the means by which we can represent it.
- b) Discuss how can one avoid repetition of works in Semantic Tableaux and also find the application of rules in descending order of preference.
- c) If  $(\forall X)(A(X) \rightarrow B(X))$  and  $(\exists X)(A(X))$  then find an  $X$  such that  $B(X)$  is true using semantic tableaux.

(6+5+7)

4. Write programs in Prolog for

- a)
  - i) finding length of a list.
  - ii) summing elements of a list of numbers.
  - iii) finding list membership.
  - iv) reversing a list
- b) If parent, male and female are given facts then write prolog rules defining father, mother, uncle, sibling, cousin.

([4x2]+[5x2])

5.

a) Transform the following formulae into PNF (Prenex Normal Form) and then into Skolem Standard Form:

i)  $(\forall x)(\exists y)(Q(x, y) \rightarrow P(x))$

ii)  $(\forall x)(P(x) \rightarrow Q(x)) \rightarrow ((\exists x)P(x) \rightarrow (\exists x)Q(x))$

b) Show that the following statements are mutually inconsistent. X is a hard working teacher. Y is a student. Y does not like X.

c) Check if the following argument is valid using resolution: All fruits are tasty if they are not cooked. This apple is cooked. Therefore it is not tasty.

(6+6+6)

6.

a) Define the following functions using SML.

1. `flatten [[1,2],[3],[4,5]] = [1,2,3,4,5]`

2. `timeslist 4 [4, 2, 5, 1] = [16, 8, 20, 4]`

3. `last [4, 2, 5, 1] = 1`

b) To calculate the mean of a list, sum the list and divide by the number of elements. To find the median take the middle element of the sorted list. For an even sized list take the mean of the middle two. The mode of a list is the most frequently occurring item. Find mean, median, and mode using SML.

(9+9)

7.

a) Find an equivalent Scheme expression to the followings that uses a lambda expression in place of let.

(i) <code>(let ((r (cdr mumbo))       (s (cdr dumbos)))   (append (s mumbo) (r jumbo)))</code>	(ii) <code>(let ((x (car mumbo))       (y (car jumbo)))   (if (eq? x y)       (x mumbo)       (y jumbo)))</code>
---	---

b) Rewrite the following expressions and replace each variable reference that occurs bound by its lexical address in the form (var:depth position).

(i) <code>(lambda (x y z)   (if (zero? x)       ((lambda (y z) (y (z x)))        (lambda (y) (z y))        y)       (cons z '(y x))))</code>	(ii) <code>(lambda (a b c)   (if (null? a)       ((lambda (c d) (c (a d)))        (lambda (a) (b a))        c)       (cons c '(a b))))</code>
---	--

c) What is metalevel programming? Illustrate how clauses may be added and deleted from the Prolog data base.

(6+6+6)