

## Functional and logic programming

- written exam -

### **Important:**

1. Subjects are graded as follows: of - 1p; A – 1.5p; B - 2.5p; C - 2.5p; D - 2.5p.
2. Prolog problems will be resolved using SWI Prolog. The following are required: (1) explanation of the code and of the reasoning behind it; (2) recursive model that solves the problem, for all the predicates used; (3) specification of every predicate (parameters and their meaning, flow model, type of the predicate - deterministic/non-deterministic).
3. Lisp problems will be resolved using Common Lisp. The following are required: (1) explanation of the code and of the reasoning behind it; (2) recursive model that solves the problem, for each function used; (3) specification of every function (parameters and their meaning).

**A.** Let L be a list of numbers and given the following PROLOG predicate definition with flow model (i, o):

$f([], -1).$

$f([H|T], S) :- \underline{f(T, S1)}, S1 < 1, S \text{ is } S1 - H, !.$

$f([_|T], S) :- \underline{f(T, S)}.$

Rewrite the definition in order to avoid the recursive call  $\underline{f(T, S)}$  in both clauses. Do NOT redefine the predicate. Justify your answer.

**B.** Given a nonlinear list that contains numerical and non-numerical atoms, write a LISP program that counts for how many sublists (including the initial list) the total number of numerical atoms on odd levels is equal with the total number of non-numerical atoms on odd levels. The superficial level is odd. For example, for the list (A B 12 (5 D (A F (B) D (5 F) 1) 5) C 9 (F 4 (D) 9 (F (H 7) K) (P 4)) X) the result will be 4 (the counted lists being (5 F) (H 7) (P 4) (5 D (A F (B) D (5 F) 1) 5) ).

**C.** Write a PROLOG program that generates the list of all subsets with N elements, using the elements of a list, such that the sum of elements from a subset is an even number. Write the mathematical models and flow models for the predicates used. For example, for the list  $L=[1, 3, 4, 2]$  and  $N=2 \Rightarrow [[1,3], [2,4]]$ .

**D.** Given a nonlinear list, write a Lisp function to return the list with all non-numerical atoms on even levels removed. The superficial level is assumed 1. **A MAP function shall be used.**

**Example** for the list (a (1 (2 b)) (c (d))) the result is (a (1 (2 b)) ((d)))